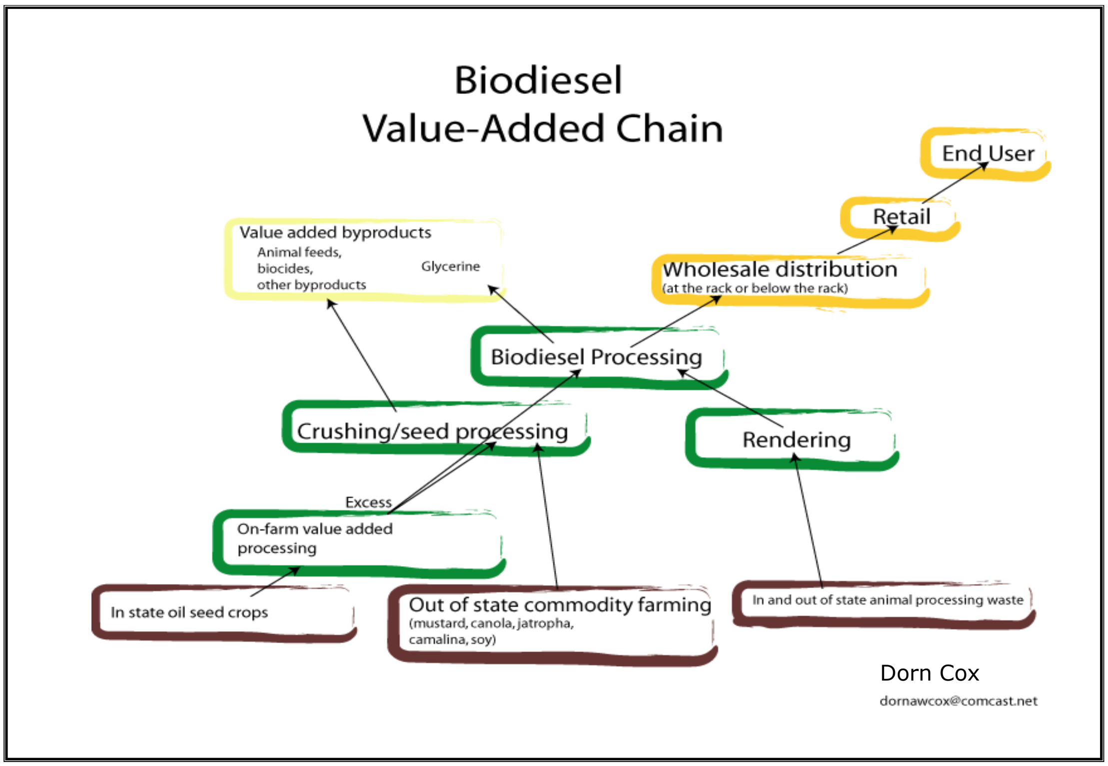
FINAL REPORT

of the

Commission to Study Production And Distribution Of Biodiesel In New Hampshire.

HB 689, Chapter 283, Laws of 2007

November 1, 2007



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Acknowledgements

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This report is a collaboration of the work of all Commission members and presenters, but some individuals made significant contributions to the report's narrative. Our thanks to Joe Broyles (Office of Energy and Planning) and Dr. Kelly Cullen (University of New Hampshire) for their economic analyses; Dorn Cox for narrative related to farm-scale biodiesel production; Dr. Melinda Treadwell (Keene State College) for details related to health impacts of diesel emissions in comparison to biodiesel; Dr. Ihab Farag (University of New Hampshire) for his expertise on oil production from microalgae; Scott Bryer (Department of Safety) for information on and proposed legislation for road toll issues; and to Joel Anderson (House Committee Research Office) and Rebecca Ohler (Department of Environmental Services) for compiling, editing and writing portions of the final report.

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Executive Summary

Biodiesel is a renewable, cleaner burning, domestically produced diesel fuel replacement. Biodiesel is often blended with petroleum diesel in various concentrations to fuel diesel vehicles and to warm homes and businesses in the winter as heating oil (bioheat). An example of a common blend is B20, a mixture of 20% biodiesel and 80% petroleum diesel.

Producing biodiesel is a fairly simple process and involves reacting vegetable oil or animal fat with an alcohol such as methanol or ethanol. The reaction produces biodiesel and the by-product glycerin for which there are various markets. A variety of oils and fats can be used in the process, including oil extracted from crops such as soybeans or sunflower seeds, fats derived from animal processing, and recycled restaurant oils and greases. Appendix A contains additional detail on the production of biodiesel.

In 2004, the citizens of New Hampshire spent over $710 million on diesel fuel and heating oil, with approximately $600 million of that leaving the state. Preliminary estimates show that nearly $60 million could have been retained in-state if the diesel fuel consumed had been B20 and the heating oil consumed had been B5, with all biodiesel production occurring and all of the associated feedstock grown in New Hampshire. Further analysis, which took into account the additive economic effects of this in-state production, indicated that up to 212 new jobs could be created, with a $210 million increase to the state's gross domestic product (GDP) and a $8.5 million increase in-state revenues[1].

At the present time, the production of biodiesel primarily relies upon vegetable oils derived from crops. It is important that any expanded use of cropland to support biodiesel feedstock production be done in a sustainable fashion that does not degrade the environment. In addition, policy makers need to be cognizant of the potential pressure that such feedstock production can have upon food supplies and prices.

There are many significant benefits associated with the use of biodiesel including:

- **Renewable energy utilization** (crops, waste grease and animal fats) that results in:
    - Less reliance on foreign oil
    - Greater fuel diversity, thereby improving supply and price stability of energy
    - Reduced greenhouse gas emissions
- **Economic opportunity** for New Hampshire farmers to grow production feedstocks and developers to manufacture the biodiesel in-state, thereby boosting the state's economy.

[1] One of the assumptions used to derive these economic benefits, that all feedstock would be produced in-state, is fairly speculative at this point as sufficient available farmland does not exist in the state to grow the necessary crops. However, research is ongoing into the technology of producing feedstock oil from algae, which is able to produce a far greater amount of oil in a given area than can crops. In addition, waste grease, tallow, and animal fats are also viable feedstock, though still limited in quantity.

- **Air emissions reductions** from diesel engines, furnaces and boilers. Use of biodiesel reduces emissions of hydrocarbons, carbon monoxide, carbon dioxide, sulfur compounds, and particulate matter, thereby benefiting public health and the environment.
- **Business cost avoidance** by extending diesel engine life and reducing maintenance due to the fuel's greater lubricity and cleaner burn.

Biodiesel shows great potential to improve the lives of New Hampshire's citizens. Examples of some of the various positive outcomes that could be expected from its adopted use include:

- A farmer cuts diesel fuel and heating oil costs by more than half by making biodiesel from crops grown on the farm and using it for farm operations.
- A school district drastically reduces the fine particulate emissions from its buses and furnaces, thereby protecting the health of all students, teachers, and staff.
- State government creates a healthier work environment, lowers maintenance costs, and increases the longevity of its diesel engines.
- A new home-grown, state-produced biodiesel industry develops which contributes significantly to the vitality of the state's economy.
- Landfills and municipal water systems experience reduced impacts from waste grease, with over 2.1 million gallons diverted from these facilities to biodiesel production facilities in the state.

All of these positive outcomes are possible by increasing production and use of biodiesel in New Hampshire. The Commission identified several barriers that currently inhibit the greater supply and use of biodiesel in New Hampshire. These include potentially higher cost, a lack of awareness regarding the benefits of using biodiesel and bioheat, inadequate local supply in areas where demand exists, an unfavorable regulatory environment for small distributors, lack of state or regional production facilities, and the need for additional research and investment in use of local crops, algae, and waste grease as biodiesel feedstock. The recommendations below are intended to address some of the barriers identified. The Commission further proposes to continue its work for another year.

Recommendations

1. **State Government Transportation Fuel.** The State of New Hampshire should lead by example by utilizing biodiesel blends in all state-owned diesel vehicles. To ensure wider use of biodiesel blends the New Hampshire Department of Transportation (NH DOT) should purchase only diesel fuel that contains at least 5% biodiesel (B5) for distribution at all state-owned fueling depots. This obligation should apply when biodiesel is available, and provided there is no additional financial burden to the state. Use of 20% biodiesel (B20) is recommended in areas where it is available and all vehicles refueling at a given NH DOT fueling depot are able to use the fuel (based on age of vehicles and engine compatibility). All biodiesel shall meet the fuel standard in recommendation #3 below. Legislation should be introduced during the 2008 session to implement this recommendation.
2. **State Government Heating Oil.** The State of New Hampshire should lead by example by utilizing a 5% bioheat fuel (B5) in all state owned buildings which currently use #2 heating oil. As biodiesel blends become available for #4 and #6 fuel oils, state buildings heated with such fuel types should also be required to use B5. This obligation should apply when bioheat is available, and provided there is no additional financial burden to the state. Bioheat should be defined by statute to refer to heating oil blended with biodiesel meeting the fuel standard specified in recommendation #3 below. Legislation should be introduced during the 2008 session to implement this recommendation.
3. **Fuel Standard.** Use of biodiesel as a motor vehicle fuel that does not meet ASTM International's D6751 standard is illegal under the provisions of the Clean Air Act Amendments of 1990. In addition, fuel not meeting this standard can cause damage to engines and other equipment in which it is used. Legislation should be introduced during the 2008 session requiring any biodiesel sold in New Hampshire meet ASTM D6751 (or any future standard that supersedes it), and granting the New Hampshire Department of Safety (NH DOS) authority to ensure compliance with the standard.
4. **Small Quantity Generators.** Licensing requirements for small quantity biodiesel producers and distributors should be eased by exempting them from having to obtain a surety bond. Legislation should be introduced during the 2008 session to implement this recommendation.
5. **State Taxation.** All motor vehicle fuel brought into or produced in-state is subject to the road toll (fuel tax) unless the fuel is colored with an identifying dye that marks it as fuel to be used for non-taxable purposes (e.g. heating oil, off-road equipment, marine fuel, etc.). The required concentration of the dye is established by federal law. New Hampshire law is set up to mirror federal law and currently requires that this dye be injected at a mechanized fuel distribution facility (known as "at the rack"). Smaller distributors and producers in the state who do not have this ability to dye at the rack have to pay the road toll on their product even if it is sold for a non-taxable purpose. This puts them at a competitive disadvantage. Federal law is being revised to allow for dying "below the rack" by manually adding dye to a fuel to reach the required dye concentration. NH DOS, who is responsible for the collection of the road toll, should adopt as soon as reasonably possible any federal tax provisions that allow for "below the rack" dying of biodiesel.

6. **Continuation of the Commission.** The Biodiesel Study Commission met seven times from July 31, 2007 through the end of October. In this short time the Commission was able to draft several concrete recommendations as proposed in this report. The Commission also recognized that increased use of renewable fuels such as biodiesel is critically important to the State's environment, public health, economic viability, and our energy security. Much work remains to be done to select proper measures that will effect lasting results. Legislation should be introduced in the 2008 session to continue the work of the Biodiesel Study Commission for an additional year with a final report to the Legislature by November 1, 2008. The legislation should add additional members to the commissions: two representatives from the petroleum distribution and marketing sector, one independent farm representative, one commercial biodiesel production representative, and one individual representing private investment interests.
7. **Children's Health.** Recognizing the increased vulnerability of children to health impacts from diesel exhaust, the Commission encourages school districts to use biodiesel for school buses and bioheat for school buildings that currently use #2 heating oil, and to enforce anti-idling policies on school grounds. The Department of Environmental Services (NH DES) should report on the use of biodiesel and bioheat by school districts to the House Science, Technology and Energy Committee and the Senate Energy, Environment and Economic Development Committee by September 1, 2009.
8. **Road Toll.** If the road toll is raised in a future legislative session, the increase should only be applied to that portion of a biodiesel blend that is petroleum diesel. Similar action by other states has had positive results in increasing use of alternative fuels. Some of the incentives offered by other states are shown in Appendix H.
9. **Federal Tax Credits.** Current federal tax credits, offered under the Energy Policy Act of 2005 in support of increased production and blending of biodiesel, expire in 2008. The tripling of biodiesel production and use from 2005 to 2006 nationally correlates to this federal tax incentive. The current New Hampshire Congressional delegation should be made aware of the importance of this tax credit to the growth of a biodiesel industry in New Hampshire and how an extension of the credit would benefit New Hampshire businesses. To implement this recommendation the Granite State Clean Cities Coalition (GSCCC), led by staff from NH DES, should ensure the delegation is informed of this issue and is invited to meetings of the GSCCC, at which this issue and the findings and recommendations of this Commission would be discussed.
10. **NH Feedstock Production.** Producing biodiesel using home-grown crops would provide some degree of energy independence and would direct dollars to struggling New Hampshire farmers rather than having them flow out of state for purchase of petroleum diesel and heating oil. Research should continue into identifying high yield strains of oilseed that can be grown in New Hampshire. Technical assistance should be provided to farmers by the University of New Hampshire Cooperative Extension in producing such crops. Funding should be sought to enable the Cooperative Extension to hire an agronomist and a specialist who could head up a sustainable agriculture and appropriate technology program as recommended in the September 2006 report from the Farm Viability Task Force (SCR 1 - 2005), *Cultivating Success on NH Farms: The New Hampshire Farm Viability Task Force Report*

11. **Local Farm Biodiesel Production.** Farms use large quantities of diesel to power their farm equipment and to heat their homes and other buildings. Current research has shown that oilseed can be grown and crushed on New Hampshire farms with the oil used to make the biodiesel onsite. The crushed meal becomes a nutritious feed for farm animals. It is recommended that the State support the pursuit of funds for ongoing farm-driven and university research on the economics of on-farm biodiesel production and methods of implementation.

12. **Biodiesel from Algae.** Microalgae may be a valuable source of biodiesel feedstock oil. The algae technology combines wastewater treatment, fuel production and production of nitrogen rich fertilizer. It is recommended that the State support the pursuit of funds by the UNH Biodiesel Group to continue and expand their algal feedstock research.

13. **Biodiesel from Waste Grease.** The burden of grease trap waste on municipal water supply providers and landfills in the region is increasing. ASMT D6751 certified biodiesel can be produced from both yellow and brown (grease trap) waste grease[2]. A concurrent and separate study commission that is specifically studying issues relative to brown grease (HB 1373, Chapter 261, Laws of 2006) has conservatively estimated the potential generation of 2.1 million gallons of brown grease in the state. Estimates for yellow grease are about the same, at 2 million gallons annually. The Commission recommends that the state support the diversion of yellow and brown grease waste from disposal facilities to fuel production facilities as production sites become available.

14. **Animal Waste Products as a Source of Biodiesel Feedstock.** Biodiesel can be produced from animal fat. The State of New Hampshire has only one slaughterhouse and no remaining rendering plants, although there is growing interest in locally raised meat. The Commission recommends that the Department of Agriculture, Markets, and Food review ways that regional slaughterhouses and rendering plants can be encouraged.

15. **Renewable Portfolio Standards (RPS).** In the 2007 legislative session, an RPS was established for the electricity sector. A side provision of the legislation required the Office of Energy and Planning to study the concept of applying an RPS requirement to thermal energy uses in the state. Bioheat would be a possible qualifying renewable. An avenue should be found for exploring the possibility of establishing a transportation RPS program where renewables such as biodiesel could be promoted in the transportation sector as well.

16. **Clean Cities Initiative.** Discussion and promotion of biodiesel usage should continue as part of the work done by GSCCC. The Commission requests that GSCCC make biodiesel discussion an agenda item in at least two of the next four quarterly stakeholder meetings and to invite to the meetings all members of this Commission, the House Science, Technology, and Energy Committee, the House Environment and Agriculture Committee, and the Senate Energy, Environment and Economic Development Committee. As time and resources allow, GSCCC is requested to help implement the recommendations of this Commission.

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[2] National Renewable Energy Laboratory, K.Shaine Tyson, Brown Grease Feedstocks for Biodiesel, June 19, 2002, http://www.nrbp.org/pdfs/pub32.pdf

Full Report of the Commission

Introduction

Petroleum diesel fuel is a critical component of our nation's energy portfolio. The highly efficient diesel engines that burn this fuel move products across our nation's road and waterways, move our population from location to location, and heat our homes. Indeed, diesel engines are the workhorses of American industry and this technology is bound to be an integral part of the U.S. economy for many years to come, as is our reliance upon this energy source to heat our homes. At this time, use of #2 heating oil accounts for over 46% of residential energy consumption in New Hampshire[3]. Although diesel engines and their fuels support much of our daily lives, these engines also present many challenges to our society that must be addressed if we are to continue to enjoy a prosperous, healthy living environment.

Diesel engine exhaust contains harmful pollutants in a complex mixture of gases and particulates. In recent years, numerous studies and rulemaking actions have identified public health hazards associated with diesel exhaust. The Environmental Protection Agency (EPA) has classified diesel exhaust as a probable human carcinogen. Exposure to diesel exhaust can cause lung damage and respiratory problems. Diesel exhaust also exacerbates asthma and existing allergies, and long term exposure is thought to increase the risk of lung cancer[4].

Increasing use of carbon based fuels, including petroleum diesel, continues to add carbon dioxide and other greenhouse gases to the atmosphere. Replacing even a small amount of the diesel fuel used in-state with renewable biodiesel can help reduce our contribution of greenhouse gases.

The rising demand for petroleum products, much of which comes from foreign, often unfriendly regimes, exposes the U.S. to economic risk should the supply of foreign petroleum be suddenly reduced. This could happen as a result of political events, war, or natural disasters that damage infrastructure. Whatever the cause, reduced supply will likely cause petroleum prices to increase rapidly. Many attribute the recessions of the 1970's in the U.S. to sharp decreases in petroleum supplies and associated price increases.

What is biodiesel?

Biodiesel is a diesel replacement fuel manufactured from vegetable oils, recycled cooking greases or oils, or animal fats. The biodiesel manufacturing process converts the oils and fats into long chain mono alkyl esters, or biodiesel. The process to make this conversion (see Appendix A) is known as transesterification, and consists of reacting the oil or fat with an alcohol (usually methanol) in the presence of a catalyst (sodium or potassium hydroxide). The resulting materials are biodiesel and glycerin.

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[3] NH Energy Facts, 2002, Governor's Office of Energy and Community Services

[4] Environmental Protection Agency, *Health Assessment Document for Diesel Engine Exhaust*, EPA/600/8-90/057F, May 2002

Biodiesel in its pure form is known as "neat biodiesel" or B100, but it can also be blended with conventional diesel, most commonly as B5 (5 percent biodiesel and 95 percent diesel) and B20 (20 percent biodiesel and 80 percent diesel). When biodiesel is blended with fuel oil for home heating it is commonly referred to as Bioheat[5].

Raw or refined vegetable oil, or recycled greases that have not undergone transesterification are not biodiesel. Current research indicates that such liquids can cause long-term damage to engines, shorten engine life, and increase emissions, but additional work is being done on this technology. This report only addresses biodiesel, not unrefined oils and greases.

Biodiesel has been used in New Hampshire for many years, most notably by the City of Keene and Keene State College who have used it since 2002 in their entire diesel fleet. In 2003, Cranmore Mountain Resort became the first ski area in the East to use biodiesel, and have had four successful seasons using B20 in their snow grooming and other diesel equipment. Other users in New Hampshire include Rymes Propane and Oils, the University of New Hampshire, Oyster River Cooperative School District, Evans Group, and Proulx Oil, to name a few. There are also numerous individuals who use biodiesel in their diesel passenger vehicles. New Hampshire currently has biodiesel available at 10 retail pumps located throughout the state and at least five heating oil dealers offer bioheat blends to their customers.

In 2004, House Bill 152 formed a biodiesel study committee that met several times and issued a final report on November 1, 2005. That report concluded that use of biodiesel is beneficial to the environment and state agencies should use, where feasible, biodiesel blends for both transportation and heating. Since 2004, availability of biodiesel and bioheat has increased dramatically in the state, and with that change in dynamics the barriers to increased use of the fuel have lessened.

While biodiesel has many positive qualities - cleaner burning, domestically produced, lower greenhouse gas emissions - there are some characteristics about biodiesel that are problematic or that differ from the comparable diesel fuel and heating oil product properties. Proper awareness of these issues can prevent problems with use of the fuel. Appendix B details these challenges.

The most comprehensive document about biodiesel and its characteristics is the *Biodiesel Handling and Use Guidelines (Third Edition),* published by the U.S. Department of Energy's Energy Efficiency and Renewable Energy program. It is available on the internet at http://www.nrel.gov/vehiclesandfuels/npbf/feature_guidelines.html or by contacting US DOE and ordering Document DOE/GO-102006-2358.

[5] National Oilheat Research Alliance, http://www.oilheatamerica.com/index.mv?screen=bioheat

The Case for Biodiesel

This Commission met seven times between July 31 and November 1, 2007. At these meetings the Commission reviewed information related to the economic, public health, environmental, and energy security impacts of increasing the use of biodiesel in New Hampshire, and in particular, use of biodiesel that was produced here in the state from locally grown feedstocks. A summary of the benefits is provided below, with additional information located in the appendices of this report.

1. Economic Benefits

The Commission used two approaches to evaluate the potential economic benefit to the state from using biodiesel. Both made the presumption that the biodiesel would not be imported, but rather produced in-state from home-grown feedstocks. Using biodiesel imported from the Midwest provides significantly less benefit to the state's economy, though it could be argued that at least the money remains within the U.S. economy rather than going into foreign economies. Other indirect benefits such as lowered health care costs due to cleaner emissions from vehicles and heating systems are not included in either analysis.

The first approach taken consisted of an analysis to determine the amount of diesel fuel dollars that would be retained in the state by substituting home-grown and produced biodiesel for a portion of the diesel fuel that is normally imported. Details are included in Appendix C. In summary, the analysis assumes that all on-road diesel fuel sold in the state is a B20 blend and all #2 oil consumed for heating purposes is a B5 blend. This amounts to 41,626,200 gallons of B100. The amount of money that would end up out of state to purchase this amount of imported diesel was calculated to be $58.4 million. Therefore, under this scenario, nearly $60 million would remain in the state to produce the biodiesel and grow the feedstock. No multiplier effects were considered, therefore this analysis could be considered the minimum gain to the economy.

The second analysis conducted took economic multipliers into account and is detailed in Appendix D. This sophisticated analysis made use of a model developed by University of Wisconsin researchers which was aimed at determining the economic impact of in-state biodiesel production plants of two different sizes, 4 million gallons per year and 10 million gallons per year. The quantity of 41,626,200 gallons of biodiesel production was used in two of the model runs, which is the same amount of biodiesel fuel use calculated in the first analysis.

The results of the analysis indicate that in the case where the production occurs at plants sized at 4 million gallons (approximately 10 plants needed in all), the total economic impact to the state would be 177 jobs created, a $136 million increase to the state GDP, and a $6.5 million increase in state revenues. Using plants sized at 10 million gallons (4 plants needed), the total impact would be 212 jobs created, a $210 million increase to the state GDP, and a $8.5 million increase in state revenues.

The assumption used in these analyses, that all feedstock would be produced in-state, is fairly speculative at this point as sufficient available farmland does not exist in the state to grow the necessary crops. However, research is ongoing into the technology of producing feedstock oil from algae, which is able to produce a far greater amount of oil in a given area than can crops. In addition, waste grease, tallow, and animal fats are also viable feedstock, though still limited in quantity.

2. Public Health and Environmental Benefits

Pollution from diesel engines is a widespread problem across the country. In New England, emissions associated with the combution of diesel fuels significantly contribute to our most problematic air pollution problems. Diesel exhaust contains small particles, known as fine particulate matter (PM2.5). Fine particles pose a serious health risk because they can easily bypass our body's defense mechanisms and reach the deepest regions of our lungs. When inhaled in high concentrations, or repeatedly at medium and low concentrations, the fine particles in diesel exhaust are believed to aggravate asthma (resulting in more frequent or severe attacks), bronchitis, and allergies or cause other serious health problems including lung cancer. Inhalation of fine particulate matter has been connected to increased hospital admissions and emergency room visits for respiratory illnesses and cardiac episodes. In 2006 the EPA adopted more stringent air quality standards for fine particulate matter and has identified diesel engine emissions as a substantial contributor to air pollution problems, particularly in urban areas. Diesel exhaust also contributes to degradation of the natural environment due to emissions of particulate matter that cause impaired visibility, sulfur dioxide that contributes to acid rain, and carbon dioxide, a greenhouse gas that may intensify our global climate change challenges.

In 2002 the EPA issued a study of the impact of biodiesel use on emissions of various compounds[6]. This report concludes that motor vehicle emissions of fine particulate matter, sulfur dioxide, carbon monoxide, hydrocarbons, and greenhouse gases are reduced through use of biodiesel and biodiesel blends. In addition, emissions of many toxic air contaminants have been shown to be reduced in laboratory emissions (dynamometer) testing, but further study on the impact on some toxic air contaminants is warranted. Appendix E summarizes the results of the EPA study, contains further discussion of air toxics emissions related to diesel exhaust emissions, and provides a summary of studies done comparing emissions from petroleum diesel and various biodiesel blends in laboratory settings or in the field.

Studies on the emissions impact of biodiesel use in heating units and commercial boilers are not as extensive as those done for on and non-road engines. However, a study conducted by Brookhaven National Laboratory and the New York State Energy Research Development Authority found the emission benefits of biodiesel/heating oil blends to be even greater than for use in motor vehicles and diesel engines[7]. A second study, also by Brookhaven National

[6] *A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions*, US Environmental Protection Agency, October 2002, EPA420-P-02-001

[7] C.R. Krishna, PhD and Roger J. McDonald, Brookhaven National Laboratory, *Paper No. 07-03 - The Green Fuel Option for the Oilheat Industry - Biofuel Research*

Laboratory[8] provided similar results, showing the use of biodiesel blends in both home heating and commercial boilers reduce emissions of particulate matter, carbon monoxide, and nitrogen oxides. In addition, biodiesel contains no sulfur, thereby reducing emissions of sulfur dioxide as well. There are a number of ongoing research studies, some being conducted in the state of New Hampshire, to more fully investigate the emissions characteristics from open flame boilers burning petroleum diesel and various blends of biodiesel.

Use of biodiesel also helps reduce carbon emissions that are associated with climate change. Pure biodiesel (B100) reduces emissions of greenhouse gases, primarily carbon dioxide, by 78%, and particulate emissions, including black carbon soot, by 47%, with proportional decreases from use of biodiesel blends. Black carbon soot is associated with climate change as it holds heat, releasing the heat in the nearby atmosphere, and also gets deposited on polar ice caps where it absorbs heat and accelerates melting of the ice caps[9]. Were New Hampshire to replace 42 million gallons of diesel with biodiesel, as discussed in the Economic Benefits section of the report, the State would decrease carbon dioxide emissions by 363,636 tons annually[10]. Reductions of black carbon soot emissions were not calculated for this report, but are in addition to the CO_2 reductions. Climate change benefits of biodiesel are somewhat reduced by fuel produced outside the region due to emissions associated with transporting the fuel to New Hampshire, but are still significant as compared to use of petroleum diesel.

3. Energy Security Benefits

In 2006 the United States had 2% of the world's crude oil reserves, produced 8% of the world's finished petroleum product, and consumed 24% of the total product consumed (Appendix F). By contrast, OPEC countries had 70% of the world's reserves, produced 41% of the world's petroleum, but consumed only 9%. The United States must, therefore, import a vast majority of its petroleum (about 60%) from foreign countries[11]. This subjects the U.S. to potential supply disruptions, and corresponding price spikes, due to events such as natural disasters, wars, or political pressures.

While the State of New Hampshire cannot impact world oil markets or significantly improve the security of the nation as a whole through production of biodiesel from state and regional feedstocks, we can impact the security of our own food and energy supplies and we can be a part of the national solution. Work done by Commission members showed that agricultural resources and existing supplies of waste oils and greases could be used to produce approximately 5 million gallons per year of biodiesel from New Hampshire-grown feedstock in the near term, using existing knowledge and technology. This is about the same amount of

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[8] C.R. Krishna, PhD, Brookhaven National Laboratory, *Biodiesel Blends in Space Heating Equipment*, May 2005, NREL/SR-510-33579

[9] U.S. House of Representatives, Committee on Oversight and Government Reform, Hearings on impacts of black carbon held October 18, 2007; http://oversight.house.gov/story.asp?ID=1550

[10] Based on 22.2 lbs of CO_2 per gallon of diesel fuel and a 78% reduction of CO_2 emissions from biodiesel. http://www.epa.gov/otaq/climate/420f05001.htm

[11] Transportation Energy Data Book, US Department of Energy, Energy Efficiency and Renewable Energy, Edition 26, Published 2007

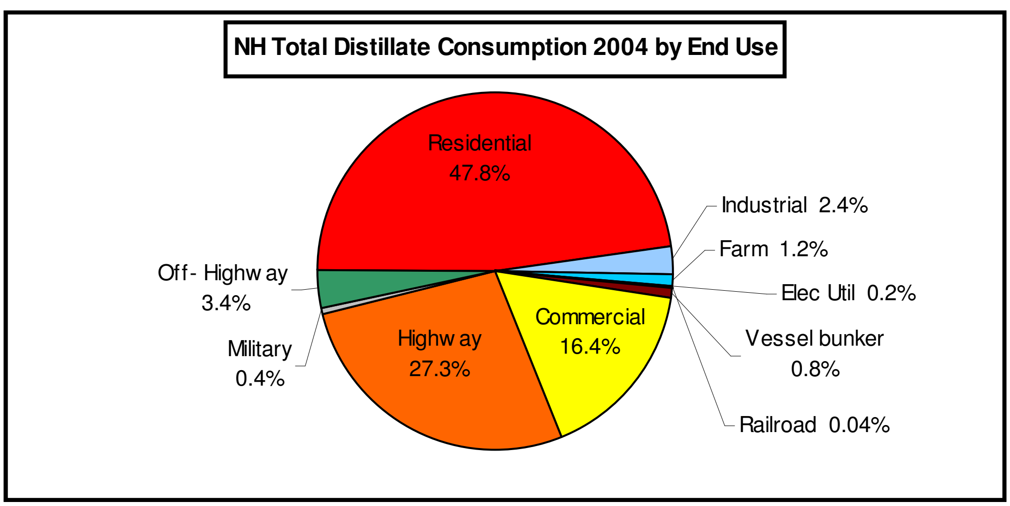
fuel used by New Hampshire farms for food production (see Appendix C). Small scale biodiesel production from oilseed crops can be set up on farms as demonstrated by current efforts of Dorn Cox at Sheltering Rock farm and Tuckaway farm in Lee, New Hampshire. This would reduce the transportation costs of the fuel overall and provide our farmers with a secure and seemingly inexpensive source of fuel. In the event of disruptions to the world oil supply chain, reliance on home-grown biodiesel will provide energy security to New Hampshire farmers and partially insulate the state's consumers from increased food costs.

Roadmap For Achieving Increased Use Of Biodiesel And Bioheat

The Commission identified six key areas in which action is necessary to break down existing barriers to expanded production and use of biodiesel in New Hampshire. In some areas concrete steps are identified and specific recommendations made by the Commission. In others, the path forward is less clear, and will be part of the focus of continuing work by the Commission should it be reauthorized for the coming year.

1. Create Awareness and Demand

While certain sectors such as municipal fleets, transit providers, school transportation providers, and other niche markets have been subject to outreach and education efforts regarding biodiesel (primarily through NH DES and GSCCC) there is still a general lack of awareness and knowledge about biodiesel by the general public. This was identified by Commission members as a barrier to increased use of the fuel in the state, particularly given the high percentage of distillate fuel that is used for residential purposes as shown in the chart below. The Commission recognizes that additional funding mechanisms to expand outreach and education efforts in relation to biodiesel and other renewable fuels will be necessary.



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As discussed previously, of the nearly 460 million gallons of diesel fuel and heating oil used in New Hampshire annually, biodiesel could replace approximately 42 million gallons with use of only B5 bioheat for all residential heating and B20 biodiesel for all on and off-highway use. At the present time, however, biodiesel is a tiny fraction of the distillate use in New Hampshire, and very little fuel is produced in-state. Total use by all in-state users has been estimated by GSCCC to be less than 400,000 gallons of pure biodiesel, most of it blended to B20 or lower blends[12]. Examples of current production and use of biodiesel in NH include the following:

- Small scale producers using waste yellow grease as feedstock and making biodiesel for their own use. One person runs his landscaping equipment on used restaurant oil which he converts to biodiesel. Several farms in the area also do this.
- One farmer who produces biodiesel from sunflower, mustard and camelina plants.
- Five heating oil distributors who buy soy-based biodiesel from the Midwest and add it to home heating oil as a 5-20% additive.
- One heating oil distributor who produces his own biodiesel from waste grease.
- A farmer who imports 1000 gallons of animal fat-based biodiesel from Canada.
- 11 gas stations which sell B20 biodiesel at the pump.
- 1 state-owned/operated B20 fueling facility utilized by the University of NH, Oyster River School District, one NH DOT truck, and miscellaneous other users.

Use of biodiesel for transportation and heating oil by state government and high profile users such as school districts, universities, and hospitals will help efforts to raise awareness of biodiesel and provide opportunities to educate New Hampshire citizens about the fuel and its benefits. The City of Keene has had a very significant impact in creating new users of the fuel by using it in their fleet and then talking about it to other fleet owners. Cranmore Mountain Resort has done the same for the ski industry, with at least three new ski areas in New Hampshire either using or planning to use biodiesel after a recent presentation by Cranmore staff, and two other ski areas researching potential sources. Use by the state fleet and in state buildings will demonstrate to the general public and other potential users the viability of the fuel itself, and enhance NH DES and others' continued efforts to advertise biodiesel's environmental and health benefits.

Two of the states largest fuel oil and diesel distributors have assured the Commission that they could and would purchase all locally produced ASTM certified biodiesel provided the cost was competitive to other sources of the fuel and/or to petroleum.

2. Create A Favorable Regulatory And Tax Environment

A favorable business environment is essential to the growth of biodiesel use in New Hampshire. The Commission identified several barriers caused by the State's regulatory and tax environment. The Commission recommended legislative changes to correct some, and others were determined to have solutions pending and no legislative action is required. The hurdles fell into two categories, regulatory and tax, and are discussed below.

[12] 2006 Annual Clean Cities Survey for Granite State Clean Cities Coalition, submitted to the US Dept. of Energy January 2007 (available from NH Dept. of Environmental Services, 603-271-1370).

Regulatory Environment

NH DES is charged with protecting the air quality in New Hampshire. State regulations exist which limit emissions of criteria pollutants addressed by the Clean Air Act, and air toxics. One barrier to increased use of biodiesel by commercial boilers is DES's air toxic rule, Env-A 1400[13]. The rule requires emission sources be able to demonstrate emissions of listed air toxics are below de minimus levels listed in the rules. While current data suggests emissions of certain air toxics are decreased by use of biodiesel, there is an indication that emissions of some compounds may be increased. However, inadequate data exists to determine if the emissions exceed Env-A 1400 thresholds, thereby making it very difficult for an emission source to make the required demonstration.

In order to address this barrier, DES has budgeted funds in the current fiscal year to conduct stack testing to determine emission levels of the air toxics of concern. DES is currently in discussions with two sources who will voluntarily use biodiesel blends and allow stack testing. It is anticipated data will be available within the next 6 to 8 months to address this issue, therefore no legislative action is required at this time.

Motor Fuel Tax Environment

The commission identified several Road Toll (motor fuel tax) barriers to the distribution of biodiesel in New Hampshire.

1. Inability to get a tax exemption on biodiesel blended in home heating oil due to the inability to inject dye below the terminal rack.
2. Lack of tax incentives or a reduced road toll on biodiesel used in motor vehicles.
3. Bonding requirements for fuel distributors that present a financial barrier to small biodiesel producers and distributors.

Currently under RSA 260:38, paragraph VI states, "Special fuel sold by a distributor on which the New Hampshire road toll fees have not been paid shall have dye and markers added to it at or before the time from withdrawal at the terminal or refinery rack…" If biodiesel is added or blended after the terminal or refinery rack there is no current provision at the federal or state level to permit splash blending after the rack. However, currently under RSA 260:47 there is a statutory mechanism to obtain a refund by the end user for motor fuel used in a tax exempt (i.e. home heating or for non-road equipment) manner. Even though a refund is available to the end user, the bioheat product has been put at a competitive disadvantage because of the taxation. NH DOS is currently researching federal legislation and regulations to determine if federal tax laws permit splash blending below or after the terminal rack. If it is allowed by federal law, there is no reason why New Hampshire could not follow suit. However, at this time without a similar provision at the federal level, NH DOS would be opposed to implementing this.

Given the poor financial health of the State's Highway Fund, it is unlikely that there will be legislative support for a tax incentive or a reduced road toll for biodiesel used in motor

[13] http://www.des.nh.gov/Rules/air.htm

vehicles. The Commission has made a recommendation that in the event of an increase to the road toll the State consider a lesser increase in the toll on biodiesel.

NH DOS informed the Commission that a reduced or tax exemption on biodiesel fuel used in motor vehicles results in additional administrative burdens for NH DOS due to the fact that they would be dealing with multiple tax rates on different types of fuel. Specifically, the International Fuel Tax Agreement (IFTA) would be difficult to administer. IFTA is a multi-jurisdiction tax agreement consisting of the 48 continental states (excludes Alaska and Hawaii) and ten of the Canadian provinces. All motor carriers based in New Hampshire, but which travel in multiple jurisdictions, are licensed and report all fuel taxes to New Hampshire. New Hampshire acts as the motor fuel tax administrator for all member jurisdictions.

Fuel distributors (which would include biodiesel producers) must currently post a $10,000 bond with NH DOS as insurance for payment of road toll fees. NH DOS believes that a legislative solution in the area of licensing and bonding of small-scale biodiesel producers can be developed to remove this financial barrier. NH DOS has proposed a new biodiesel distributor license which would allow business entities importing or producing less than 10,000 gallons of biodiesel per month to operate without a surety bond. Once the business entity exceed more than 10,000 gallons per month they would be required to meet the bonding requirements of RSA 260:37. Details on the precise legislation proposed can be found in Appendix G.

Several states offer incentives for the production, distribution, or use of biodiesel. Appendix H contains a summary of some of those offered. The effectiveness of tax incentives is clearly demonstrated by federal incentives for biodiesel that were introduced through the American Jobs Creation Act of 2004 and the Energy Policy Act of 2005. These incentives helped to spur a threefold growth in the biodiesel production capacity in the U.S. from 2005 to 2006[14]. In testimony before the Commission on September 27, 2007 representatives from Irving Oil indicated that the recent expiration of tax incentives for biodiesel in Maine immediately lowered demand for biodiesel in the state.

3. Ensure High Quality Biodiesel in the State

Like petroleum fuels, the quality of biodiesel fuel is of primary importance. ASTM International is a standards group comprised of engine manufacturers, fuel producers, fuel users, and others. ASTM standards are recognized by most government entities within the U.S. The specification for neat biodiesel (B100) is ASTM D6751 (-03 is the current version) and is intended to insure the quality of the biodiesel entering the market. Biodiesel that does not meet the ASTM standard can contain contaminants that may cause damage to engines and diesel equipment and could cause increased emissions of air pollutants.

Fuel quality is also of concern to original engine manufacturers (OEM) who provide a warranty on their products. While an OEM warranty is on the workmanship of the engine itself and does not extend to damage caused by fuel, be it biodiesel or petroleum diesel, OEMs are justifiably concerned with the quality of fuel that goes into their products. Any

[14] see http://www.biodiesel.org/pdf_files/fuelfactsheets/Production_Graph_Slide.pdf

engine failure, whether or not it is covered by a warranty, reflects poorly on their product. Under federal law, an OEM cannot void a warranty simply because someone uses biodiesel in the engine. But, should poor quality fuel be used and damage occur, it will not be covered by the OEM warranty. To avoid this situation, only biodiesel meeting the ASTM specification should be used, and users should obtain their fuel from reputable suppliers who will stand behind their product.

The Clean Air Act Amendments of 1990 (CAA) provide the EPA with the authority to regulate fuels and fuel additives in order to reduce the risk to public health from exposure to their emissions. The regulations[15] require that each manufacturer or importer of gasoline, diesel fuel, or a fuel additive, have its product registered with EPA prior to its introduction into commerce. Registration involves providing a chemical description of the product and certain technical, marketing and health-effects information. This allows EPA to identify the likely combustion and evaporative emissions. EPA uses this information to identify products whose emissions may pose an unreasonable risk to public health, warranting further investigation and/or regulation. Biodiesel that meets ASTM D6751 has undergone the necessary health effects and emissions testing, has been determined to not increase the risk to public health, and is a legally registered motor vehicle fuel and fuel additive for use in highway and non-road diesel vehicles. Any biodiesel fuel not meeting ASTM D6751 is not a legally registered fuel and should not be used in diesel engines.

The Commission has recommended legislation be introduced during the 2008 session requiring any biodiesel sold in New Hampshire meet ASTM D6751 (or any future standard that supersedes it), and that NH DOS be granted the authority to ensure compliance with the standard. This will help protect New Hampshire consumers, ensure that the environmental benefits are realized, and provide stability to the growing New Hampshire biodiesel market.

4. Support Sustainable Regional And Local Sources Of Feedstock And Production

The most common feedstock for U.S. produced biodiesel is soybean oil, accounting for over 80% of production. Soy is grown primarily in the Midwest and Southern states, but is not a suitable crop for New England (although some is grown in Maine). For this reason, most biodiesel is currently produced in states that grow soy.

Fortunately, biodiesel can be produced from most any vegetable oil or animal fat. There are many promising, alternative biodiesel feedstocks that can be grown in New England. Examples include the oil seed crops of mustard, camelina, and sunflower, which have yielded 61, 62 and 102 gallons per acre, respectively, when tested by regional land grant universities.[16]

Crops that grow well in one region with a given soil type and microclimate may not grow well 50 miles away. These microclimates and soil variability conditions are especially

[15] Title 40 Code of Federal Regulations Part 79

[16] The University of New Hampshire, the University of Vermont, and the University of Maine. See Appendix I for a table of tested crops and their yields.

common in the New England region. This points to the need for research to determine which crops grow best in various conditions in the region.

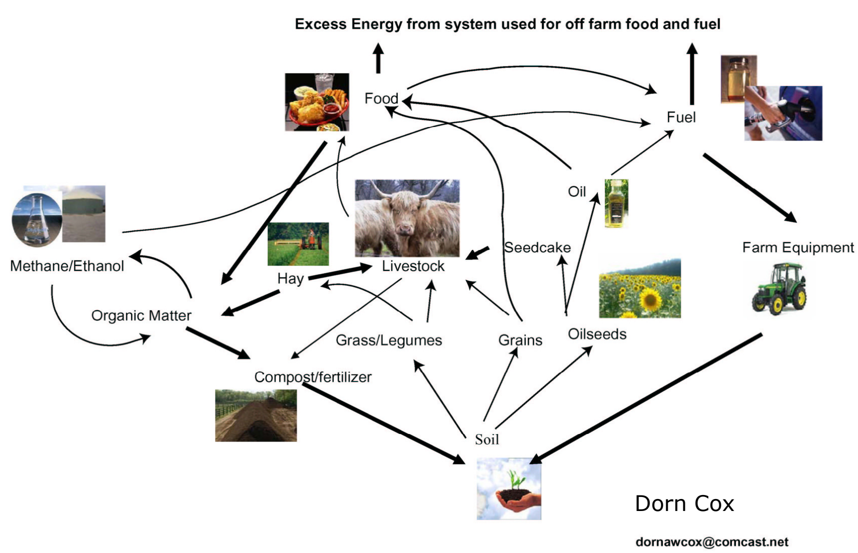
There is one small, commercially sized biodiesel production facility that has been constructed in New Hampshire and which is scheduled to begin its operations soon. The owner plans on initially using imported soybean oil to produce the biodiesel, though the commodity's rapid rise in price during the past year has forced him to look at other possible feedstocks. He is interested in using locally grown feedstocks or even oil produced at an in-state facility that crushes imported oil-seed. At present, no such facility exists.

It appears uncertain, and some would say doubtful, that oil produced from local crops will be able to compete in the near future with the commodity price of vegetable oils from other parts of the country. This type of problem is commonly faced by New England farmers. They find it extremely difficult to directly compete in the national and often international commodities markets. This has forced them and their supporting institutions to be creative in finding more specialized, innovative, and value-adding uses of their farmland.

Unlike the massively large and capital intensive infrastructure required to extract and refine crude oil into transportation and heating fuels, the process of refining plant feedstocks into biodiesel can be done on a relatively small scale, often right on the farm, with capital investments in the thousands of dollars rather than billions. This has been done successfully by several New Hampshire farmers, as well as those from around the country and the world.

One of the key advantages of the local biodiesel model over reliance on imports is that it enables a far shorter supply chain. The end products can be produced on the same farm where the crops are grown, or even just down the road. This form of distributed production enables the farmer or local entrepreneur to capture far more of the retail price than they might otherwise gain by selling a crop at commodity prices. There is great potential for the farmer/entrepreneur to also process and refine the many high value byproducts from biodiesel crops such as specialty food grade oils and high value animal feeds. This model also adds more expertise, capacity and income to rural economies.

Closing Loops



Research and development is needed to further refine the local biodiesel production model and to expand the local knowledge base relative to the crops, equipment and technology that can make this model economically viable. Bottom up and locally focused research and development should be done in which farmers, businesses, entrepreneurs and end users are study participants, thereby assuring early and rapid adoption of any promising results.

5. Support Emerging, Alternative Technologies Of Oil Production

New Hampshire does not appear to have enough available cropland to support growing biodiesel feedstock in sufficient quantities to significantly reduce the amount of petroleum diesel and heating oil used in the state. Other states in the region may have relatively more cropland, but still it is limited when compared to large agricultural states. There is also the hurdle of making a compelling enough case to farmers to convince them to switch from what they currently grow, and perhaps make a profit from, to biodiesel feedstock crops.

The oil production potential of local biodiesel feedstock crops tends to be limited to around 100 gallons per acre. In contrast, microalgae have the potential to produce 5,000 to 10,000 gallons of biodiesel per acre. The UNH Biodiesel Group is investigating microalgae as a potential valuable source of biodiesel feedstock oil. The energy and labor inputs required for growing algae can be substantially less than those for land crops.

Microalgae require light, nutrients, and carbon dioxide, and have the ability to grow rapidly in regular, brackish and salt water. While being grown in a photo-bioreactor, they convert light to produce much more oil per unit area of land then can crops. Some microalgae store up to 70% of their dry mass energy reserves in oil droplets. The microalgae's nutrient source may be treated wastewater effluent. This provides an appealing symbiotic use for algae production, tying it with removal of eutrophying nutrients from waste streams. The carbon source can be CO_2-rich flue gas from combustion or aerobic digestion of waste products. Thus, the algae technology has the potential of combining wastewater treatment and CO_2 sequestering to produce a renewable fuel and a nitrogen rich fertilizer.

The primary challenge to making algal biodiesel commercially viable is reducing the capital cost of the photo-bioreactor systems used for the high growth stage of the algae. Current systems have costs at least ten times higher than what would be necessary for an appealing economic return. Further research and development is needed to design new photo-bioreactors that can be built with less expensive materials and less labor.

6. Ensure Reliable Distribution

The Commission had participation from several petroleum distributors, including Rymes Propane and Oil, Evans Group, Lamprey Brothers, Rye Fuel, and Irving Oil. In addition, a representative from New Hampshire's Oil Heat Council was a Commission member. Petroleum distribution is a complex model, with petroleum products distributed from a limited number of terminals in the Northeast (Portsmouth, NH, Albany, NY, Portland, ME and Boston, MA). Some distributors have their own bulk storage facilities, but those closer to the terminals usually do not. Storage capacity is further strained by differing fuel sulfur requirements recently implemented for on and non-road fuel, and the high sulfur content of heating oil as compared to diesel fuels. A shortage of biodiesel blending facilities that are able to maintain the fuels at adequate temperatures for year round blending also complicates the market scenario.

Currently, blended biodiesel is available at major terminals in Portland, ME, and Albany, NY. In addition, there are a few New Hampshire petroleum distributors that import B100 from the Midwest and Canada by rail and then blend that product with heating oil and/or diesel fuel for distribution to their customers. A small number of heating oil distributors purchase B100 from these importers and blend batches of bioheat in their delivery trucks for distribution. However, this scenario only works when the heating oil distributor is located relatively close, geographically, to the importer and has a good working relationship with them. Thus, growth of bioheat as a viable alternative is limited in this model.

As mentioned above, though biodiesel and bioheat are available at a few terminals in New England, access is limited to those who can purchase in tractor trailers for large deliveries or those who are close enough to the terminal to justify loading directly into their retail delivery trucks for immediate delivery. With the current mix of fuels in the New Hampshire market (15 part per million (ppm) sulfur on-road fuel, 500 ppm sulfur non-road fuel, and high sulfur (~3000 ppm) heating oil, reliable distribution of biodiesel is attainable only when heating oil and motor fuels distributors add biodiesel storage capacity to their existing bulk storage facilities. This scenario would change were biodiesel blends to be mandated in the state, an action not currently recommended by this commission as further study on this issue is warranted.

Fuel infrastructure is expensive and distributors need to match the level of infrastructure to the level of demand for a particular fuel. This investment will only occur if demand for biodiesel and bioheat rises dramatically. Demand for biodiesel and bioheat are influenced by many factors, but availability of tax or other incentives is the most significant. Awareness, as discussed under item #1 is also a key influence. Demand can also be positively influenced by a combination of mandated use by the government and/or joint marketing efforts by the State and biodiesel distributors.

List of Appendices

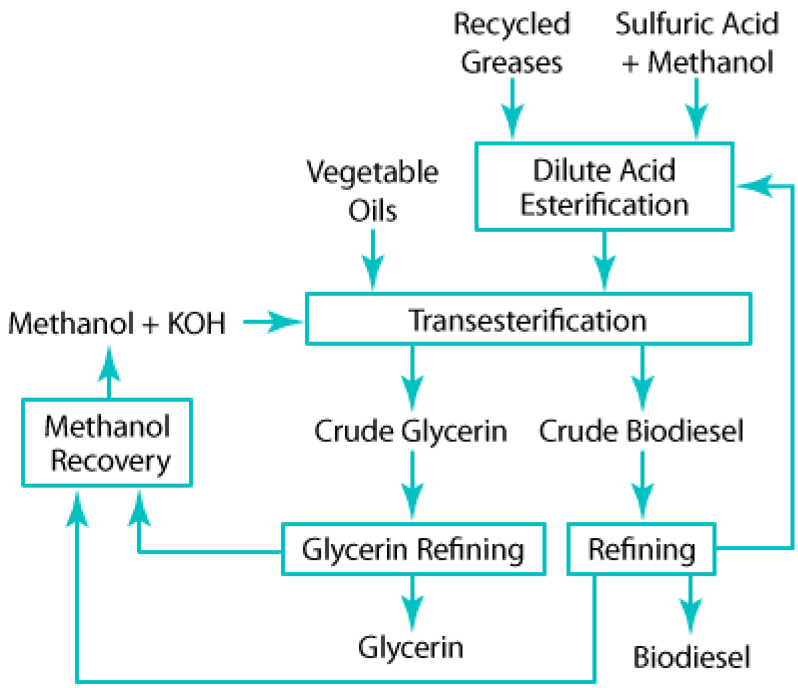
Appendix A - Biodiesel Production

Biodiesel can be made from any type of new or used vegetable oils and animal fats, which are nontoxic, biodegradable, and renewable. Fats and oils are chemically reacted with an alcohol (methanol is most commonly used in the United States) to produce chemical compounds known as fatty acid methyl esters. Biodiesel is the name given to these esters when they are intended for use as fuel. Glycerin (used in pharmaceuticals and cosmetics, among other markets) is produced as a co-product. The feedstock directly affects the characteristics of the final fuel, particularly the cloud point of the fuel (the temperature at which the fuel starts to gel), therefore some feedstocks are more desirable for Northeast fuel than others. Biodiesel made from sources that result in a higher cloud point are more suitable for either southern markets or for use as bioheat where storage of the fuel tends to be indoors.

The most common feedstock for US produced biodiesel is soy oil, accounting for over 80% of all biodiesel produced here. Soy is grown primarily in the Midwest and Southern states, but is not a suitable crop for New England (although some is grown in Maine). For this reason most biodiesel is currently produced in states that grow soy. The cost of soy oil has risen dramatically in the past year, appearing to track rising petroleum prices, reaching a current high of about $3.50 per gallon. Conversely, the cost of imported oils is staying low, with palm oil from Malaysia available for approximately $0.63 per gallon. However, growing demand for palm oil is resulting in deforestation in some areas to increase the acreage of palm monoculture.

Another common feedstock is waste grease from restaurants and food production, also known as "yellow grease." Many small "home brew" operations make biodiesel from yellow grease collected from local restaurants. Commercial scale production from yellow grease is a viable operation, and several such plants exist in the Northeast. "Brown grease", or grease from grease traps and septage systems is also a viable biodiesel feedstock. Supplies of yellow and brown grease are limited and New Hampshire (or any other state) will not be able to meet fuel needs through use of yellow or brown grease feedstock alone.

Biodiesel can be produced using a variety of esterification technologies. The oils and fats are filtered and preprocessed to remove water and contaminants. If free fatty acids are present, they can be removed or transformed into biodiesel using special pretreatment technologies. The pretreated oils and fats are then mixed with an alcohol (usually methanol) and a catalyst (usually sodium hydroxide). The oil molecules (triglycerides) are broken apart and reformed into methyl esters and glycerin, which are then separated from each other and purified.



Schematic of biodiesel production path.

U.S. Department of Energy - Energy Efficiency and Renewable Energy
Alternative Fuels and Advanced Vehicles Data Center

Appendix B - Biodiesel Challenges

Some of the key challenges with use of biodiesel are:

1. The cloud point of neat biodiesel (B100) is much higher than conventional diesel fuels (35°F to 65°F for biodiesel versus -9°F to 10°F for diesel fuel) and can impact handling procedures as well as ability to use the fuel in some conditions. Use of fuels that have begun to gel, thus raising the fuel viscosity, can cause damage to some engines. Fuel additives are used to keep both diesel fuel and biodiesel blends operable in colder weather. Users can avoid any problems by establishing adequate specifications for the fuel supplier to meet. Several additives specific to biodiesel blends are available on the market and can be added either to the storage tank or to the vehicle directly. While fuel meeting established cold weather specifications should not need any additional additives, it may be useful to have some additional additive on hand in case of extreme weather conditions.

2. Biodiesel is a powerful solvent. At blends of B5 or below no impact will likely be noticed, but at higher blends sediments and sludges in tanks, or carbon deposits on engines, may be loosened and go through fuel or oil filter systems, causing clogging of the filters. It is common to have to change fuel and oil filters shortly after you begin using biodiesel blended fuel.

3. Biodiesel can degrade some "rubber" fuel system components, such as hoses and pump seals. This is especially true with higher-percentage blends, and older vehicles. Many newer vehicles have biodiesel-compatible components, but it is best to consult your owner's manual or contact your vehicle manufacturers for specific information.

4. For blending, biodiesel should be kept at least 10°F above its cloud point to successfully blend with diesel fuels in cold weather.[17] In order to ensure proper blending techniques have been followed, biodiesel blends should always be purchased from a reputable supplier who has the equipment and the knowledge to properly blend the fuels.

These challenges are all surmountable and have not been a significant issue with existing biodiesel users in the state. As noted in the report, users should always obtain their fuel from a reputable supplier and use only biodiesel that is certified to meet ASTM D6751.

[17] Biodiesel Cold Weather Blending Study, Cold Flow Blending Consortium

Appendix C - Economic Impacts (Analysis #1)

Hypothetical Illustration of Potential Dollars Retained

OEP Projection of NH Total Biodiesel Bio-component Demand[1]				
Total Petroleum Distillate Uses, 2004	**Total %**	**Total Gallons**	**Total TBtu**	**Total bbl**
Electricity generation	1.6%	7,224,000	0.936	172,000
Heat	72.8%	333,732,000	46.222	7,946,000
Transportation	25.6%	117,474,000	15.213	2,797,000
Total Gallons	**100.0%**	**458,430,000**	**62.370**	**10,915,000**
Potential Bio-component Demand				
Electricity generation (if B20)	3.5%	1,444,800	0.187	34,400
Heat - all uses (if B5)	40.1%	16,686,600	2.161	397,300
Transportation (if B20)	56.4%	23,494,800	3.043	559,400
Total Potential Bio-component Demand[2]	**100.0%**	**41,626,200**	5.391	991,100
Potential Bio-component Demand as % of 2004 Total NH Energy Demand:	**1.2%**	**...and as % of 2004 NH Distillate Energy Demand:**	**8.6%**	

1. Based on 2004 summary data from US DOE Energy Information Administration, State Energy Data Summary for NH. 2004 is the latest year for which EIA has compiled state summaries.

2. This ignores any additional total fuel volume required because of biodiesel's lower energy content relative to petroleum diesel. Additional volume demand is unlikely, however, as B20 blend contains an average of approximately 98.3% as much energy as No. 2 diesel. Furthermore, energy content of conventional diesel fuel can vary as much as 15%; thus the theoretical energy loss in B20 might be difficult to document in actual use. Data Source: federal reports cited on National Biodiesel Board web site: http://www.biodiesel.org/pdf_files/fuelfactsheets/BTU_Content_Final_Oct2005.pdf

Other notes:
TBtu= Trillion British Thermal Units
Heat content for #2 heating oil is usually given as about 138,500 Btu/gallon; thus this value, and not the #2 diesel value of 129,500, was used to calculate TBtu for total heating oil consumption.

Economy Sectors Consumption, bbl				
Comm.	**Indus.**	**Res.**	**Trans.**	**Elec.**
				172,000
1,835,000	775,000	5,336,000		
			2,797,000	

- J. Broyles, Energy Program Manager, Office of Energy and Planning 8/15/07

OEP Estimate of Dollars That Were Exported from NH to Purchase Diesel Fuel and #2 Oil, 2004		
NH Diesel Fuel and #2 Oil End Uses	$Million Nominal Spent	$Million Nominal Exported
Electricity generation	8.3	7.1
Heat	479.6	410.1
Transportation	222.4	182.1
Totals	**$710.3**	**$599.3**

Hypothetical Illustration of Dollars That Could Have Been Retained if NH-produced Biodiesel Had Been in Use, 2004		
NH Diesel Fuel and #2 Oil End Uses	$Million Nominal Exported	$Million Nominal Retained
Electricity generation (if B20)	7.1	1.4
Heat - all uses (if B5)	410.1	20.5
Transportation (if B20)	182.1	36.4
$Million Nominal Retained:		**$58.4**

Source Documents, Assumptions and Calculations for Illustrations Projections

Diesel Fuel Components History

Figure 2: Diesel Fuel Price Components, 2004

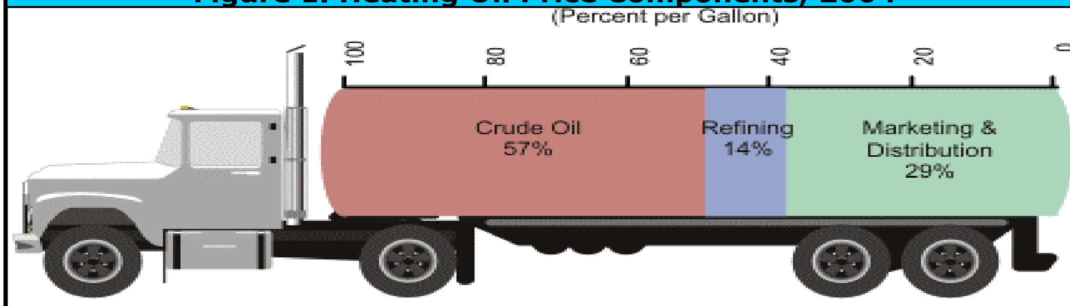
Source: http://tonto.eia.doe.gov/oog/info/gdu/dieselpump.html

Mo/Year	Retail Price	Refining Cost	Distrib. & Market.*	Taxes	Crude Oil Cost
	Cents/gal	%	%	%	%
January-04	155.1	13.1	7.7	31.1	48.1
February-04	158.2	11.8	9.6	30.5	48.1
March-04	162.9	11.7	10.1	29.6	48.2
April-04	169.2	14.7	9.4	28.5	47.4
May-04	174.6	17.5	9	27.6	45.9
June-04	171.1	14.3	10.6	28.2	46.9
July-04	173.9	15.4	6.5	27.7	50.4
August-04	183.3	14.2	6.7	26.3	52.8
September-04	191.7	17.3	5.3	25.1	52.3
October-04	213.4	18	6.2	22.6	53.1
November-04	214.7	15.2	13	22.4	49.3
December-04	200.9	16.2	13.8	24.9	45
EIA US Average Price	**180.8**				
EIA US Average % of $ Paid/Component		**15%**	**9%**	**27%**	**49%**
NH Est. Export % of $ Paid/Component		100%	50%	50%	100%

2004 Ratios for calculating $ Exported from NH	**%**
Crude Oil (100% of EIA value)	49%
Refining (100% of EIA value)	15%
Taxes (50% of EIA value; OEP **assumes** state and fed. tax rates were approx. =)	14%
M&D (OEP **assumes** 50% of M&D plus corporate overhead leaves NH)	4%
Total Assumed % of Diesel Fuel Dollar that leaves NH:	**82%**

* Assumed to include corporate overhead.

Figure 1. Heating Oil Price Components, 2004



Source: *Reuters* spot prices, EIA's *Petroleum Marketing Annual, 2004*.

OEP Source:
http://www.eia.doe.gov/bookshelf/brochures/heatingoil/heatingoil2005/index.htm

2004 Ratios for calculating $ Exported from New Hampshire	%
Crude oil % (100% of the EIA value)	57
Refining % (100% of the EIA value)	14
M&D/2 (assume: half M&D and half company overhead leave NH)	14.5
Total Assumed % of Heating Oil Dollar that leaves NH:	**85.5**

NH OEP Illustration of NH Dollars Exported for Energy, by Sector and Total
by Joseph C. Broyles Energy Program Manager
NH Office of Energy and Planning

This illustration includes only those energy expenditures that could conceivably be offset at least in part by use of NH-produced biodiesel in the proportions indicated on the consumption page.

Methodology, Assumptions and Qualifying Comments
Approximation based on US DOE EIA 2004 data for consumption and expenditures and EIA 2004 Diesel and Heating Oil price breakdowns (see Diesel and Heating Oil Breakdown tabs in this spreadsheet).
Assume all crude and refining costs are exported from NH.
Assume EIA "Distribution and Marketing" costs include corporate overhead; and that 50% of all these costs leave NH.
For on-road diesel, assume 50% of taxes were federal and thus exported.
No need to correct for differences in end-user prices for the various sectors, because we are looking at expenditures, not prices.
Impossible to determine different marketing and distribution percentages for various end-use sectors; this is one example of uncertainty inherent in this model.

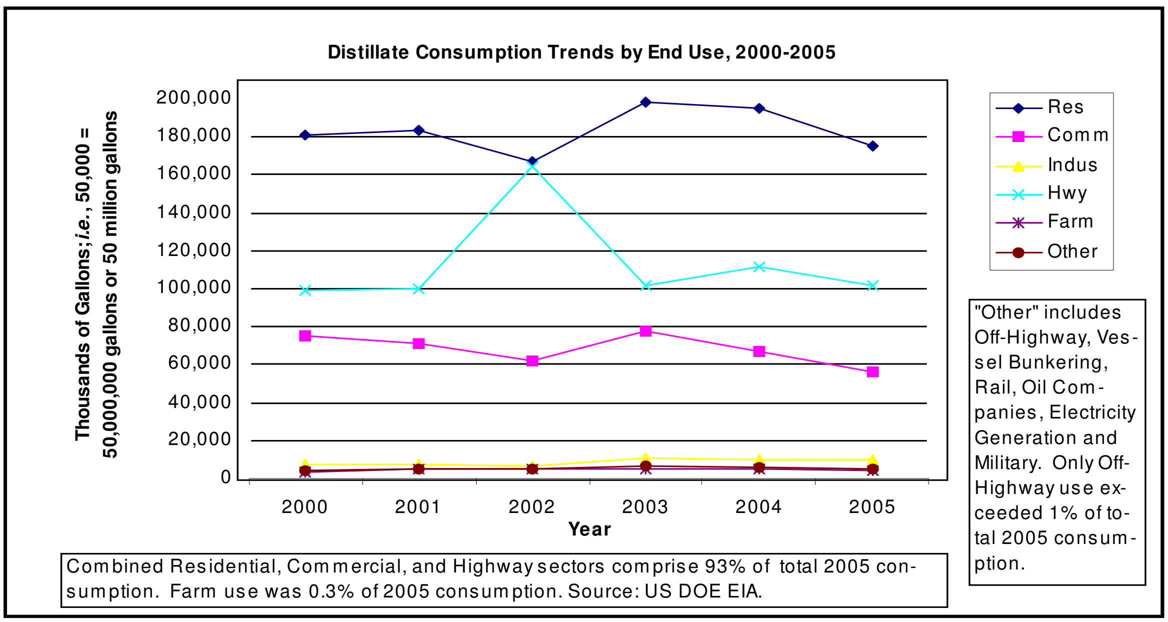
Calculation of % $Nominal Exported from NH for Diesel Fuel and #2 Heating Oil, 2004

Sector Details and Total :	Fuel	$million spent	$million exported	Notes
Commercial	"Distillate"	100.1	85.6	Assume EIA "Distillate" is #2 Oil
Industrial	"Distillate"	44.0	37.6	Assume EIA "Distillate" is #2 Oil
Residential	"Distillate"	335.5	286.9	Assume EIA "Distillate" is #2 Oil
Heat Subtotal		*479.6*	*410.1*	
Transportation*	"Distillate"	222.4	182.1	Assume EIA "Distillate" is all #2 Diesel
				*On-road diesel fuel only
Electricity Gen.	"Distillate"	8.3	7.1	*Per* EIA: "Distillate" includes #1 and #2, kero and
				jet fuel. Assume all can be blended with biodiesel.
Grand Totals		**$710.3**	**$599.3**	
% of fuel cost that was exported:			**84.4%**	Averaging EIA % and not $ - as here- yields 85.5%.

Yearly estimates will vary depending on fluctuating proportions of such factors as crude oil and refining costs in total retail cost. Note also that EIA price breakdowns are national or regional, not NH averages.

Distillate Consumption Trends by End Use

- **Residential consumption** is heavily influenced by winter temperatures, likely obscuring any potential trends. Demand may decrease as winters continue to moderate and as housing stock and heating systems become more thermally efficient. Householders' price-influenced primary heating fuel choices and any increase in housing units also complicate projection efforts.
- **On-highway diesel consumption** spike in 2002 may represent faulty EIA data, or it may reflect the temporary shift from air transport to trucking after September 11, 2001. The magnitude of the increase (over 60%) suggests an error in published data.
- **Farm consumption** - 0.3% of total consumption - is too small to drive markets. However, the ability to produce and consume their own bio-fuels could enhance farms' economic viability, particularly if there is no concomitant reduction in their usual marketable products' volume.
- **Logging industry consumption,** not identified by EIA, is probably included in Off-Highway. Logging industry demand is unlikely to be a market driver, but savings from reduced equipment maintenance and, possibly, lower fuel prices could bolster logging industry viability.



Appendix D - Economic Impacts (Analysis #2)

prepared by Dr. Kelly Cullen, University of New Hampshire

As of September 7, 2007, 45 states have commercial biodiesel production plants (National Biodiesel Board, 2007). New Hampshire is not one of those 45 states. New Hampshire is poised to see dramatic economic benefit due to the fact that residents are currently purchasing their biodiesel from out of state.

Researchers in our neighboring state of Vermont spent two years investigating the Biodiesel demand, supply, production and jobs (Delhagen, 2006). The study involved a commercial scale pilot project in which biodiesel was used in heating and fleet transportation, as well as a sate-wide educational component. The total amount of biodiesel used in this pilot study was 78,500 gallons of blended oil, which reduced greenhouse gas emissions by about 179 tons. They concluded that biodeisel holds great potential for the future security of their state's energy supply, economic development and environmental protection.

In another recent study conducted by researchers at the University of Wisconsin (Fortenbery and Deller, 2006), it was estimated that the multipliers connected to Biodiesel productions are significant. For a four million galler per year biodeisel production facility, each new job in the facility would create 1.7 jobs for the state. Each dollar of biodiesel sales would generate $1.09 in local gross domestic product (GDP), and for every dollar that goes to pay a facility employee, $2.08 would be seen as an increase in local income.

The results for a ten million gallon a year facility are even better, due to the economies of size. Each job created by the facility would result in 2.55 jobs for the state. Each $1 in biodeisel sales would generate $1.68 in local GDP, and each dollar paid to a facility employee would translate into $3.41 in income for the state.

The researchers at the University of Wisconsin were careful to state that previous studies conducted by special interest groups tended to over or underestimate potential economic impacts. The publication of a university study is important because the results are unbiased and thus more likely to be reliable. The researchers indicated that these impacts are to be considered a lower bound as they do not account for short term employment of facility construction.

What numbers could we expect in New Hampshire?

In the testimony before the U.S. House of Representative's Small Business Committee, Joe Jobe, CEO fo the National Biodiesel Board cited that the average biodiesel plant produces about 8 million gallons a year. The estimates for this study will look at plants with the capacity to produce 4 and 10 million gallon per year.

Using the model developed by the University of Wisconsin researchers, we can estimate the economic impacts from creating biodiesel production plants in New Hampshire. For this model, the basic assumptions are that a 4 million gallon per year plant would employ an average of 10 employees, making an average income of $30,000 per year. The 10 million gallon per year plant would employ 20 people, also making an average of $30,000 per year.

We also assume that the average price for distillate (Diesel and #2 Oil) is $3.00 per gallon. Finally, we shall use 2004 figures of distillate consumption from (US DOE Energy Information Administration, 2007).

Table 1: Economic Impacts from 4 million gallons per year Biodiesel Plants

	Direct Impact	Total Impact
B20 Diesel / B5 Heating Fuel:		
Number of Plants Needed	10.4	
Jobs	104	177
State GDP	$124,878,600	$136,117,674
State Income	$3,121,965	$6,493,687.20
B100: number of Plants Needed	114.6	
Jobs	1146	1948
State GDP	$1,191,918,000	$1,299,190,620
State Income	$34,382,250	$71,515,080

Table 2: Economic Impacts from 10 million gallons per year Biodiesel Plants

	Direct Impact	Total Impact
B20 Diesel / B5 Heating Fuel:		
Number of Plants Needed	4.2	
Jobs	83	212
State GDP	$124,878,600	$209,796,048
State Income	$2,497,572	$8,516,721
B100: number of Plants Needed	45.8	
Jobs	917	2338
State GDP	$1,191,918,000	$2,002,422,240
State Income	$27,505,800	$93,794,778

The figures estimated in the above tables show the potential significant positive impact the state of New Hampshire could see if it were to invest in biodiesel production plants. The data shows impacts under two assumptions: 1) state residents, businesses and government use a 20% biodiesel mix for all diesel and a 5% biodiesel mix for heating fuel, and 2) the state uses 100% biodiesel.

Using the more modest 20% / 5% biodiesel mixes, the state could see as many as 212 new jobs, an increase of about $209.8 million in GDP and an increase of about $8.5 million in income.

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Appendix E - Biodiesel Emissions

Appendix E contains the following:

- National Biodiesel Board summary of the results of EPA's analysis of the impact of biodiesel on diesel exhaust
- A graphic depiction of this same data from the U.S. Department of Energy
- An Overview of the Composition of Diesel Exhaust Emissions, Dr. Melinda Treadwell, Keene State College
- An Overview of Keene State College Study on the Impact of Biodiesel Use on Emissions from Diesel Engines, Dr. Melinda Treadwell, Keene State College

From the National Biodiesel Board:

Biodiesel is the first and only alternative fuel to have a complete evaluation of emission results and potential health effects submitted to the U.S. Environmental Protection Agency (EPA) under the Clean Air Act Section 211(b). These programs include the most stringent emissions testing protocols ever required by EPA for certification of fuels or fuel additives. The data gathered complete the most thorough inventory of the environmental and human health effects attributes that current technology will allow. EPA has surveyed the large body of biodiesel emissions studies and averaged the Health Effects testing results with other major studies. The results are seen in the table below. To view EPA's report titled "A comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions" visit: www.epa.gov/otaq/models/analysis/biodsl/p02001.pdf.

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL, ACCORDING TO EPA

Emission Type	B100	B20
Regulated		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
Nox	+10%	+2% to -2%
Non-Regulated		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

* Estimated from B100 result
** Average reduction across all compounds measured
*** 2-nitroflourine results were within test method variability

The ozone (smog) forming potential of biodiesel hydrocarbons is less than diesel fuel. The ozone forming potential of the speciated hydrocarbon emissions is 50 percent less than that measured for diesel fuel.

Sulfur emissions are essentially eliminated with pure biodiesel. The exhaust emissions of sulfur oxides and sulfates (major components of acid rain) from biodiesel are essentially eliminated compared to diesel.

Criteria pollutants are reduced with biodiesel use. Tests show the use of biodiesel in diesel engines results in substantial reductions of unburned hydrocarbons, carbon monoxide, and particulate matter. Emissions of nitrogen oxides stay the same or are slightly increased.

Carbon Monoxide -- The exhaust emissions of carbon monoxide (a poisonous gas) from biodiesel are on average 48 percent lower than carbon monoxide emissions from diesel.

Particulate Matter -- Breathing particulate has been shown to be a human health hazard. The exhaust emissions of particulate matter from biodiesel are about 47 percent lower than overall particulate matter emissions from diesel.

Hydrocarbons -- The exhaust emissions of total hydrocarbons (a contributing factor in the localized formation of smog and ozone) are on average 67 percent lower for biodiesel than diesel fuel.

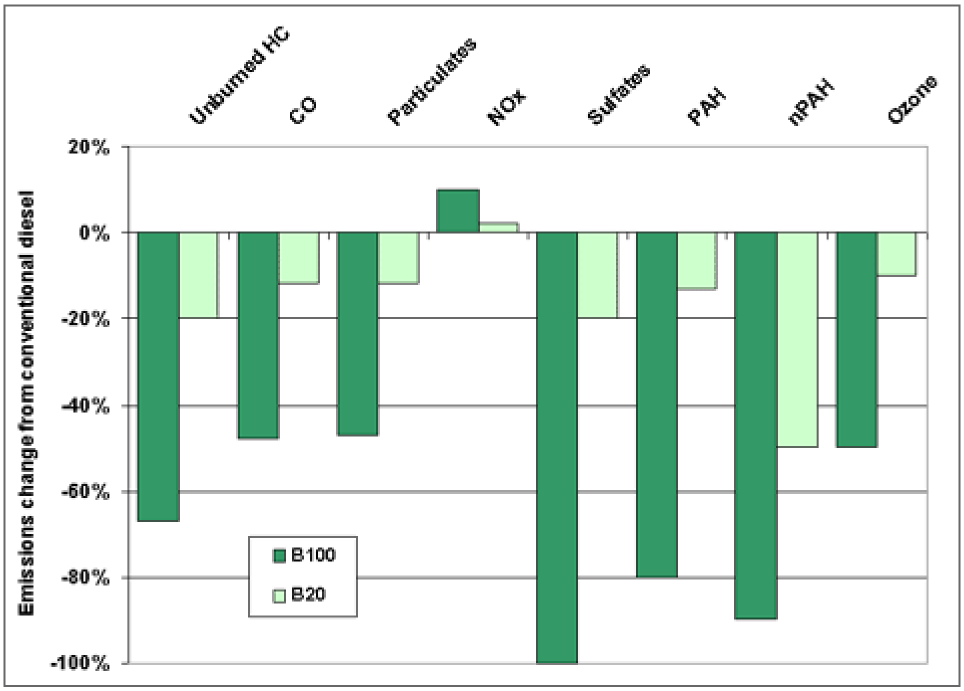
Nitrogen Oxides -- NOx emissions from biodiesel increase or decrease depending on the engine family and testing procedures. NOx emissions (a contributing factor in the localized formation of smog and ozone) from pure (100%) biodiesel increase on average by 10 percent. However, biodiesel's lack of sulfur allows the use of NOx control technologies that cannot be used with conventional diesel. Additionally, some companies have successfully developed additives to reduce Nox emissions in biodiesel blends.

Biodiesel reduces the health risks associated with petroleum diesel. Biodiesel emissions show decreased levels of polycyclic aromatic hydrocarbons (PAH) and nitrated polycyclic aromatic hydrocarbons (nPAH), which have been identified as potential cancer causing compounds. In Health Effects testing, PAH compounds were reduced by 75 to 85 percent, with the exception of benzo(a)anthracene, which was reduced by roughly 50 percent. Targeted nPAH compounds were also reduced dramatically with biodiesel, with 2-nitrofluorene and 1- nitropyrene reduced by 90 percent, and the rest of the nPAH compounds reduced to only trace levels.

Source: National Biodiesel Board website -
http://www.nbb.org/pdf_files/fuelfactsheets/emissions.pdf

From the U.S. Department of Energy - Energy Efficiency and Renewable Energy FreedomCAR and Vehicle Technologies Program is the following graphic depiction of the EPA emissions reduction data.

Difference in Emissions from B100 and B20 to Conventional Diesel



Supporting Information

Average Biodiesel (B100 and B20) Emissions Compared to Conventional Diesel		
Emission Type	**B100**	**B20**
	Emissions in relation to conventional diesel	
Regulated Emissions		
Total Unburned Hydrocarbons (HC)	-67%	-20%
Carbon Monoxide (CO)	-48%	-12%
Particulate Matter	-47%	-12%
Nitrogen Oxides (NOx)	+10%	+2%
Non-Regulated Emissions		
Sulfates	-100%	-20%[a]
PAH (Polycyclic Aromatic Hydrocarbons)[b]	-80%	-13%
nPAH (Nitrated PAH's)[b]	-90%	-50%[c]
Ozone potential of speciated HC	-50%	-10%

Source: Oak Ridge National Laboratory, *Biomass Energy Data Book: Edition 1*, ORNL/TM-2006/571, September 2006, p. 55. Original source: "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions."
[a] Estimated from B100 result.
[b] Average reduction across all compounds measured.
[c] 2-nitroflourine results were within test method variability.

Source: U.S. Department of Energy - Energy Efficiency and Renewable Energy FreedomCAR and Vehicle Technologies Program, Fact Sheet #449: December 25, 2006, Biodiesel to Conventional Diesel: An Emissions Comparison

An Overview of the Composition of Diesel Exhaust Emissions

prepared by

Dr. Melinda Treadwell, Keene State College

In recent years, sentinel studies and rulemaking actions have identified the primary public health hazards associated with diesel engine emissions (HEI, 1995, 2002; EPA 2001, 2002b, 2002c, 2004; McDonald 2004; Pandya 2002). Researchers and regulatory agencies believe that diesel exhaust is a "potential occupational carcinogen" (NIOSH 1988), and "likely to be carcinogenic to humans by inhalation" from environmental exposures (EPA 2002b). In addition, other researchers have concluded that diesel exhaust causes pulmonary inflammation and histopathology (EPA 2002b, 2002c), and that it may contribute to allergic responses and asthma (Wade and Newman, 1993; Mauderly 2001, 2002; McDonald 2004; EPA 2002b, 2002c). Incidence of asthma has more than doubled from the 1978 to 1998 time period, affecting over 17 million people and highlighting the concern about possible associations between asthma and combustion related products such as diesel exhaust (EPA 2002c). There is concern in the environmental policy arena regarding diesel's association with lung cancer risk, including at the lower exposure levels typically experienced by the public. A detailed cohort study of railroad workers with occupational exposure to diesel exhaust indicated elevated lung cancer mortality (Garshick 2004). During combustion of diesel fuel many fine (≤ 2.5 μm) and ultra-fine (≤ .1 μm) particles are released, which present particular hazards due to their ability to penetrate into the deep lung (EPA 2002b; HEI, 1995, 2002). The composition of these particles includes both elemental carbon (30-90% of total composition) and organic compounds (7-19% of total composition) which are likely to induce carcinogenic and mutagenic effects (EPA2002b). With respect to fine particles, in 1998 the US EPA suggested that, when excluding natural and miscellaneous sources, diesel exhaust was responsible for 23% of the national ambient $PM_{2.5}$ inventory. This percentage ranges from 4 to 53% from rural to urban areas across the country (EPA 2001, 2002b).

Under the Clean Air Act, the US EPA has focused on fine particles as a major pollutant of public health concern-recently adopting a more stringent National Ambient Air Quality Standard for $PM_{2.5}$, lowering it from 65 $\mu g/m^3$ to 35 $\mu g/m^3$ (EPA 2007). Recent rulemaking to control the public health concerns associated with diesel fuel have focused on reducing fine particulate matter mass emissions from these engines, considered a primary national emissions source of $PM_{2.5}$ by the EPA (EPA 2001, 2004).

Diesel particulate matter adsorbes a host of organic compounds including: semi-volatile organic compounds (SVOC's), polycyclic aromatic hydrocarbons (PAH's) and nitro-polycyclic aromatic hydrocarbons (HEI 2002). These adsorbed compounds in petroleum diesel exhaust are a major health concern as a number of PAH's and n-PAH's are known to be carcinogenic. Comparative study of the organic fraction of biodiesel diesel exhaust and exhaust from varying biodiesel/petroleum diesel blends is limited at this time. However, Bagley and colleagues (1998) found lower vapor phase PAH's and lower particle bound PAH's in a soy-based biodiesel compared to petroleum diesel. Higher total PAH concentrations were determined in a soy-based biodiesel compared to a rapeseed based biodiesel (Bunger 2000). Yet other researchers found little difference in adsorbed SVOC PAH's between pure biodiesel and various diesel fuel blends (Durbin 2000).

In studies funded by the National Institutes of Health in Keene, New Hampshire, researchers have demonstrated highly statistically significant reductions in airborne fine particulate matter concentrations (65% lower exposures than when burning conventional petroleum diesel fuels, $p < 0.0005$). These same studies have demonstrated a no significant change in elemental carbon (soot) and a highly significant increase in adsorbed organic compound mass ($p < 1.02$ E-8) when burning B20 in non-road construction equipment, no highly significant. It is unknown if the increased organic fraction seen in previous Keene State College research, as well as others (Durbin 2000), is due to adsorbed species of relatively low toxicity, such as methyl esters from unburned fuel, or due to other combustion products. Current laboratory testing, as noted previously would suggest that highly toxic compounds are not likely increased with biodiesel blending. Additional research is ongoing to more fully characterize these emission components.

Overview of Keene State College Study on the Impact of Biodiesel Use on Emissions from Diesel Engines

prepared by

Dr. Melinda Treadwell, Keene State College

For the past several years Keene State College has been developing an undergraduate research program with funding from the US Environmental Protection Agency and from the National Institutes of Health. Faculty and undergraduate students have conducted ambient occupational and environmental exposure analyses in settings where workers are exposed to emissions from nonroad equipment operating on petroleum diesel fuel. These analyses have concluded that nonroad equipment operations will increase ambient fine particulate matter concentrations by up to 16-fold and elemental carbon concentration up to 6-fold. Furthermore, toxic air pollutant concentrations (e.g., acetaldehyde and formaldehyde) are several hundred times higher than established risk screening thresholds for workers and residents living near operating equipment (Treadwell *et al.* NESCAUM Report, 2003 and manuscripts in preparation).

Seeking emission and exposure reduction options for heavy duty diesel engines in the near term, Keene State researchers have been working with the college fleet management department and the City of Keene NH Department of Public Works. Based on engine dynamometer testing results that show biodiesel and biodiesel blends reducing emissions of carbon monoxide, particulate matter, and hydrocarbons when compared to petroleum diesel engines (EPA, 2002); the City and College collaborative has begun to assess the real-world occupational and environmental exposure impacts of biodiesel fuel combustion. Since 2004, faculty and undergraduate students have utilized methods developed earlier (Treadwell 2003) to investigate ambient exposure impacts of petroleum diesel-fueled engines at sites where these engines are used extensively. This research has endeavored to quantify changes in ambient air concentration, and hence exposure, of fine particulate matter with burning 20% biodiesel (B20) in nonroad engines (Treadwell and Traviss manuscripts in preparation). As shown in the following figures, our most recent exposure analyses have concluded that a 20% biodiesel blend will reduce fine particulate matter mass to a level below the federal health protective threshold established by the US EPA mass exposures (average exposure reduction of 65%, $p = 0.0005$) while increasing the organic carbon mass (average exposure increase of approximately 450%, $p = 0.00000001$), and not significantly altering elemental carbon concentrations in samples ($p=0.44$) (Figures 1, 2 , 3 and 4).

We postulate that the significant reduction in ambient fine particulate matter mass is due to the increased temperature of combustion associated with a B20 fuel blend. The methyl ester (biodiesel) acts as an oxygenate during the combustion process and it is likely that fuel is burned more efficiently- creating the significant mass reductions we have consistently observed in our early work. It is plausible that particulate matter morphology will be dramatically changed with this increased temperature of combustion, but to date, the morphology of B20 fuel combustion emissions have remained uncharacterized. Lastly, our observation of a dramatic increase in organic carbon concentration is an area for future research. Depending upon the chemical speciation of this emission fraction, this early observation could suggest increased or decreased potency associated with particulate matter and adsorbed organics.

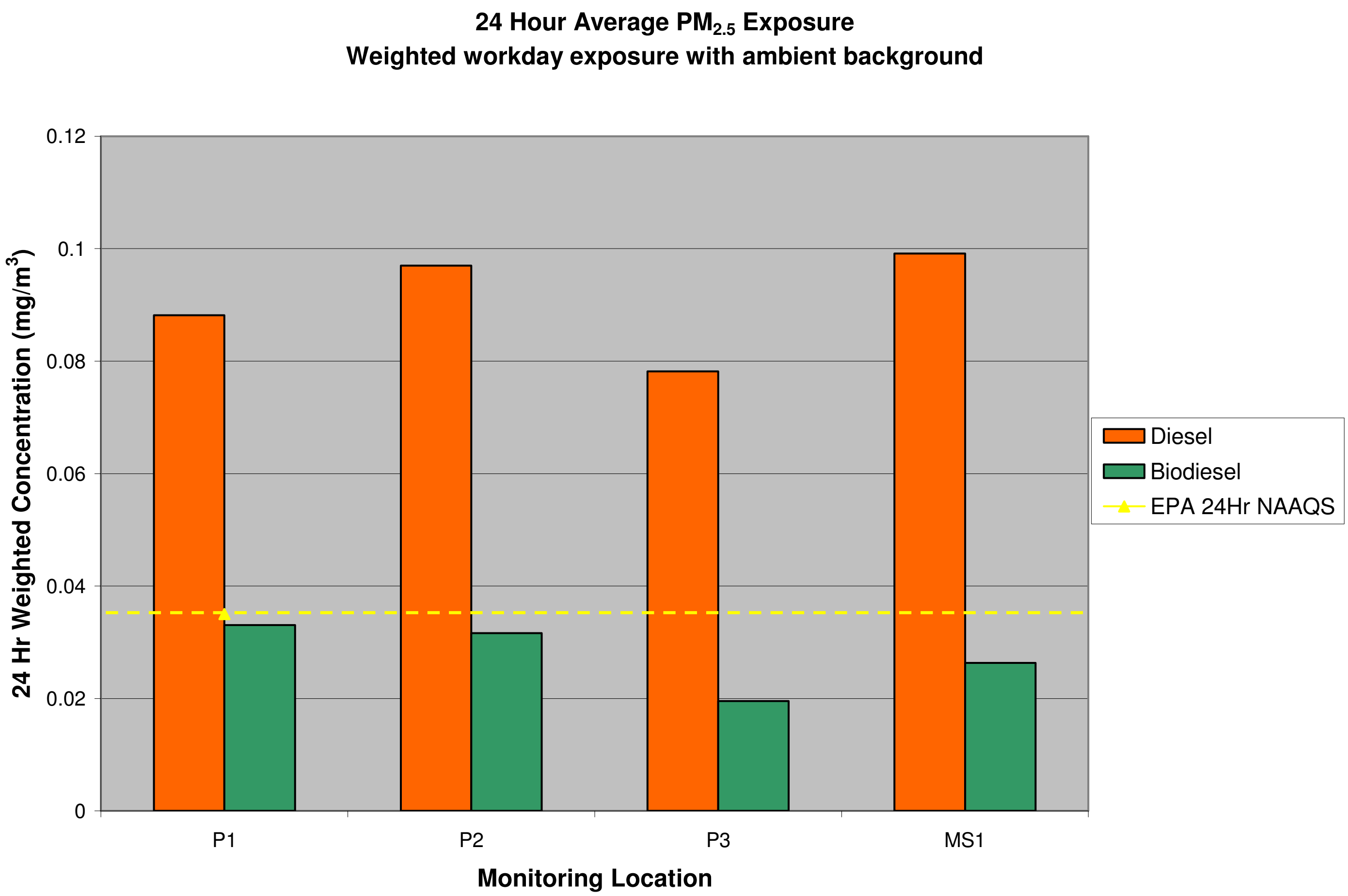
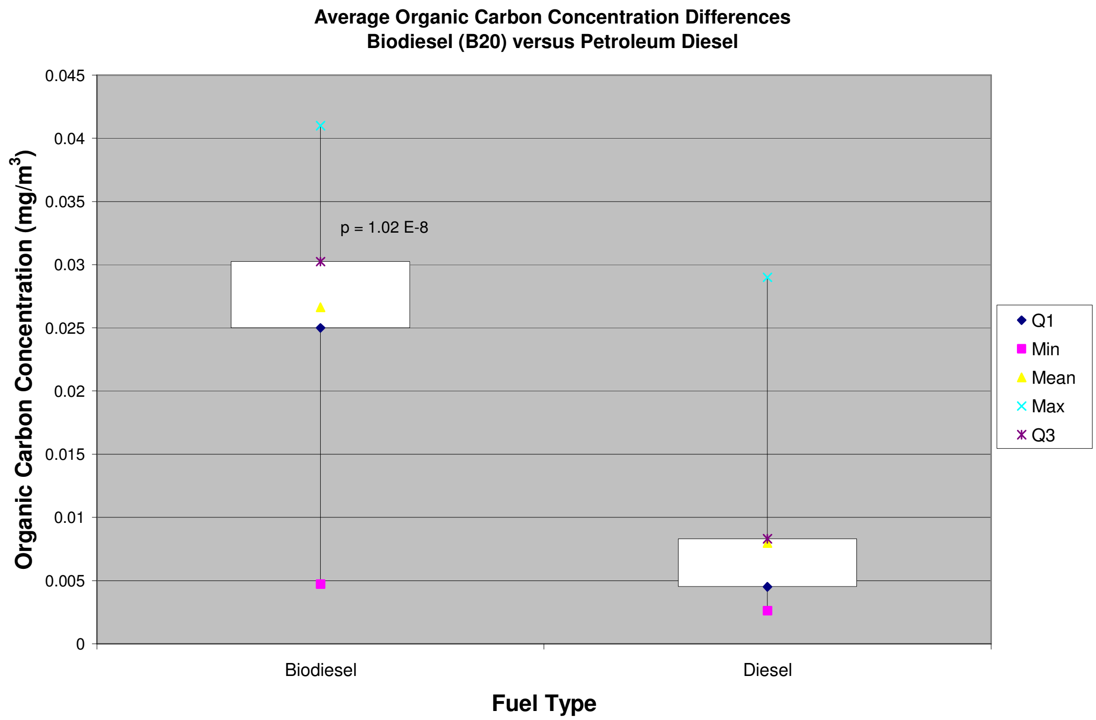


Figure 1: 24hr weighted occupational and environmental average $PM_{2.5}$ mass exposures from diesel and biodiesel monitoring days at each monitoring location (perimeter or mobile source) as compared to the Environmental Protection Agency's National Ambient Air Quality Standard of 0.035 mg/m^3



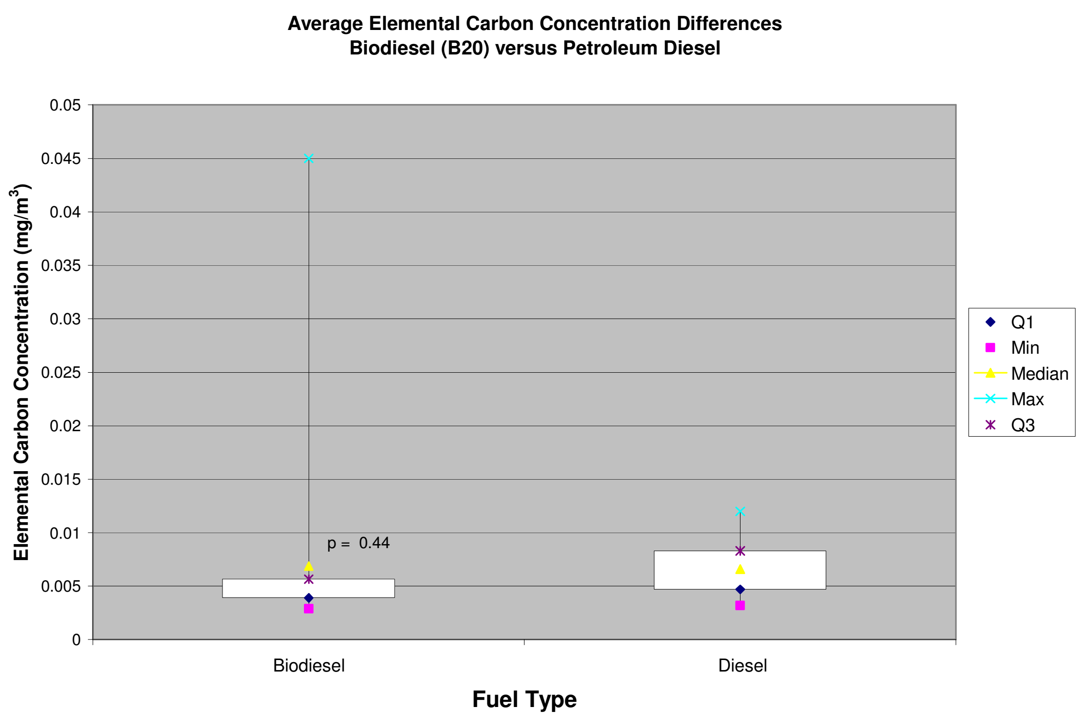


Figure 2 and 3. Statistical analyses of particulate (organic carbon and elemental carbon) emissions differences between B20 and petroleum diesel. A B20 blend significantly increased organic carbon concentrations (p=1.02 E-8) while, in these same samples, elemental carbon concentrations were not significantly changed with biodiesel fuel blending (p=0.44).

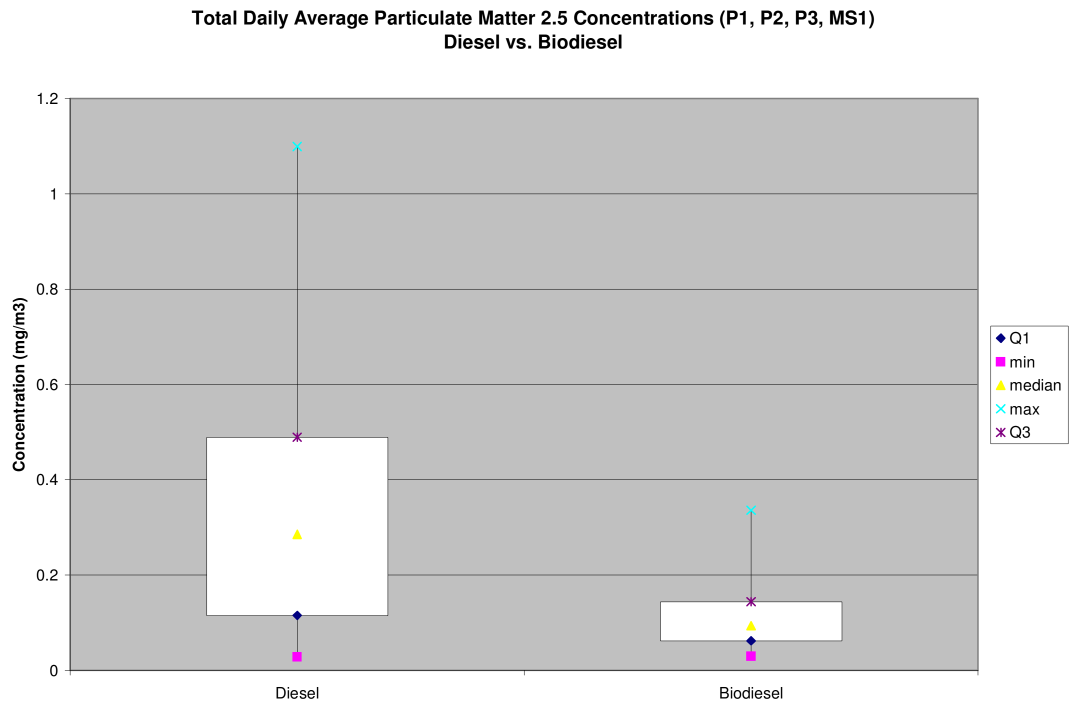


Figure 4. Statistical analyses of fine particulate matter emissions differences between B20 and petroleum diesel. A B20 blend significantly reduced the fine particulate matter concentrations ($p=0.0005$) in the breathing area of non-road construction equipment operators.

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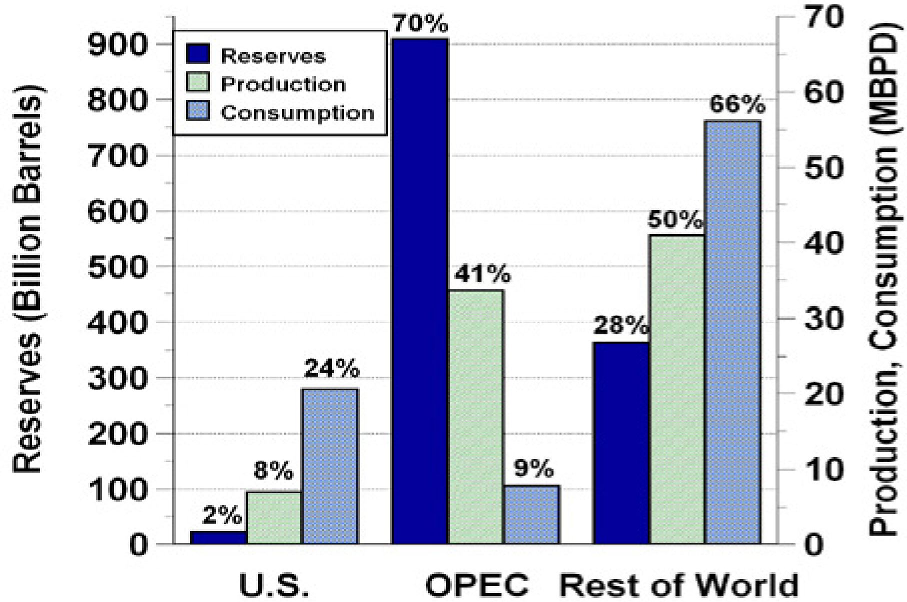
Appendix F - Energy Security

World Oil Reserves, Production, and Consumption, 2006

The United States was responsible for 8% of the world's petroleum production, held 2% of the world's crude oil reserves, and consumed 24% of the world's petroleum in 2006. The Organization for Petroleum Exporting Countries (OPEC) held 70% of the world's crude oil reserves and produced 41% of world petroleum.

World Oil Reserves, Production, and Consumption, 2006



Supporting Information

World Oil Reserves, Production, and Consumption, 2006

	Crude Oil Reserves (billion barrels)	Reserve Share	Petroleum Production (million barrels per day)	Production Share	Petroleum Consumption (million barrels per day)	Consumption Share
United States	21.8	2%	6.9	8%	20.6	24%
OPEC	908.8	70%	33.6	41%	7.8	9%
Rest of World	362.4	28%	40.9	50%	56.1	66%

Sources:
Reserves – Energy Information Administration, *International Energy Annual 2005*, Table 8.1.
Production – Energy Information Administration, *International Petroleum Monthly, July 2007*, Tables 4.1a–4.1d and 4.3.
Consumption – Energy Information Administration, *International Petroleum Monthly, May 2006*, Table 4.6.
OPEC consumption (2005 data) – *Energy Information Administration, International Energy Annual 2005*, Table 1.2.

Appendix G - Proposed Legislation for Motor Fuel Tax Statutes

RSA 260:36-b Biodiesel Distributors License

Any person who refines, distills, prepares, blends, manufactures, or purchases biodiesel, on which the Road Toll has not been paid and is not a licensed and bonded distributor in accordance with RSA 260:37, shall become licensed with the Department.

I. Any licensee that refines, distills, prepares, blends, manufactures, or purchases more than 10,000 gallons of biodiesel in a monthly period shall be required to file with the department a bond in accordance with RSA 260:37.
II. For all non-bonded licensees an annual fee for the license shall be twenty-five dollars.
III. Each Biodiesel Distributor Licensee shall file a monthly return with the department in accordance with RSA 260:38-I.

RSA 259:6-a Biodiesel. Biodiesel as used in the road toll and motor fuel provisions of this title shall mean a renewable special fuel that is composed of mono-alkyl esters of long chain fatty acids, is derived from vegetable oils or animal fats and shall meet the ASTM standard of D6751.

RSA 259:6-b Blended Biodiesel. Blended biodiesel means a blend of biodiesel fuel meeting ASTM D6751 with petroleum based fuel. (Example: B20 is 20% biodiesel and 80% petroleum diesel.) The percentage of biodiesel must be labeled on invoices, bills of lading, and other pertinent records and papers as may be necessary for the reasonable administration of this subdivision.

We recommend that the effective date for this legislation be January 1, 2009.

We further recommend that legislation be introduced to enable the State to perform fuel analysis on said biodiesel product to ensure compliance with ASTM standard of D6751 and include provisions for noncompliance with the ASTM standard.

Appendix H - Summary of State Incentives

Table based on information derived from the Alternative Fuels and Advanced Vehicles Data Center of the Energy Efficiency and Renewable Energy Program within the U.S. Department of Energy. Citations at the website (www.eere.energy.gov/afdc/fuels/biodiesel_laws.html) were consulted when further clarification was needed. The table does not include the many state planning initiatives taking place or some of the relatively minor incentives being offered. Table prepared by Joel Anderson, House Committee Research Office.

State	Fuel Tax Credit or Exemption	Other Tax Exemptions, Deductions, or Credits or Incentive Payments		Fuel Mandate	State Vehicle Mandate	Other
		Production	Distribution & Retail Sales			
Alabama						
Alaska						
Arizona					State, local govt., & school districts in high population areas must use alternative fuels including biodiesel	State outside contracts in certain counties to give incentives to biodiesel use in heavy-duty equipment
Arkansas		Payments of 20¢/gal up to \$2 M. Up to \$2 M for new feedstock processing facilities. Programs expire 7/1/09. Tax credit of 10¢/gal.	\$50,000 grant for new distribution and storage facilities until 7/1/09		B2 by 2009. Waiver available if greater than 15¢/gal more expensive	
California						Research and production funding
Colorado			20-44% tax credit for refueling infrastructure		B20 if not greater than 10¢/gal more expensive	
Connecticut		30¢/gal payments for first 5 M gals, 20¢/gal for second 5 M, and 10¢/gal for third 5 M. Grants of 25% of construction costs	\$50,000 grant for new storage and distribution facilities			R&D grants to CT ag and educational institutions for algal, crops and waste grease research
Delaware						
Florida		Until 2010, 75% credit for capital, maintenance, operations and R&D	Until 2010, 75% credit for capital, maintenance, operations and R&D. Sales and use tax exemption until 2010.			R&D and commercialization
Georgia					Fueling facilities to maximize biodiesel, as economical.	

State	Fuel Tax Credit or Exemption	Other Tax Exemptions, Deductions, or Credits or Incentive Payments		Fuel Mandate	State Vehicle Mandate	Other
		Production	Distribution & Retail Sales			
Hawaii	Tax rate is 25% of diesel rate					Tax credit for R&D. Energy feedstock program created in Dept of Ag
Idaho	Biodiesel portion exempt, limited to 10% of total fuel volume		Until 2011, 6% tax credit for refueling infrastructure. Pending approp., 50% grant for refueling infrastructure			
Illinois			80-100% exemption on sales of biodiesel blends		B2, also includes towns, schools & colleges	Rebate of 80% of incremental cost of B20 or above - open to all
Indiana	Personal use of B20 or above blends are exempt, where biodiesel made by individual	$1/gal credit - capped at $3 M total per producer unless extended to $5 M. 2¢/gal for blended product made in-state using in-state produced biodiesel. 1¢/gal if use out-of-state biodiesel	1¢/gal of sales of blended biodiesel product through 2010		Price preference of 10% for B20 and above blends. Includes towns. Purchase B2 or greater whenever possible	R&D on alt fuel technologies
Iowa		Various tax credits	Through 2011, 3¢/gal for B2 or higher provided 50% of sales at station are biodiesel blends. Up to 50% or $50,000 for distrib. terminals	Renewable fuel standard - retailers must sell an increasing percentage of biofuels (up to 25% by 2020) as part of gasoline sales	All bulk purchases B5 – 2007 B10 – 2008 B20 - 2010	$100 M R&D fund for biofuels. No interest loans for production facilities. Low-interest loans for feedstock production
Kansas		20¢/gal payments	3¢/gal incentive for sale of B2 starting in 2009, increasing to B25 threshold in 2024. 40% tax credit for infrastructure		B2 if not greater than 10¢/gal more expensive	
Kentucky		$1/gal producer/blender credit - capped at $1.5 M			B2 as primary fueling option	
Louisiana		Sales & Use tax exemption		2% biofuel 6 months after certain level of in-state production		Any in-state production plant must get at least 2.5% of feedstock from home-grown soy
Maine		5¢/gal tax credit	Through 2008, 25% tax credit for refueling infrastructure			

State	Fuel Tax Credit or Exemption	Other Tax Exemptions, Deductions, or Credits or Incentive Payments		Fuel Mandate	State Vehicle Mandate	Other
		Production	Distribution & Retail Sales			
Maryland		20¢/gal for soybean biodiesel, 05¢/gal all others. 5 M gal/yr state limit			50% of fleet to use B5 by 2008	
Massachusetts					B5 by 2008 for all on and off road diesel engines. B15 by 2010 if feasible	
Michigan	3¢/gal reduction for B5 blends, contingent on Leg reimbursing highway fund	Industrial property tax exemption	Refueling station grants up to 75% of cost			
Minnesota				B2 at least	B20 or above if available at similar cost. 10% reduction in diesel use by 2010, 25% by 2015	
Mississippi		Until 2015, 20¢/gal payment - max of $6 M per producer.			Encourage the use of biodiesel where feasible	
Missouri		Payments in a given year of 30¢/gal for first 15 M gal, 10¢/gal for second 15 M gal with a 5 year limit, provided facility is at least 51% owned by in-state ag producers or 80% of feedstock comes from in-state.			75% of DOT vehicles and heavy equipment - at least B20, provided incremental cost not more than 25¢/gal	Through 2012 school districts receive incremental costs of using at least B20, provided purchased from nonprofit, farmer-owned, new generation cooperatives
Montana		Payment of 10¢/gal for each year of increased production. 3% property tax abatement plus 15% tax credit on new facilities	2¢/gal payment on B100 distributed & 1¢/gal retail sale. 15% tax credit for storage and blending facilities.			
Nebraska		30% tax credit for facilities if at least 51% owned by in-state entities			Biodiesel blends whenever reasonably available	Low cost loans for refueling infrastructure
Nevada					Alternative fuel vehicle standard in high pop areas includes biodiesel	Fines for air pollution violations available for school bus biodiesel use

State	Fuel Tax Credit or Exemption	Other Tax Exemptions, Deductions, or Credits or Incentive Payments		Fuel Mandate	State Vehicle Mandate	Other
		Production	Distribution & Retail Sales			
New Hampshire						
New Jersey						Local govt., colleges, schools, farmers paid incremental cost of biodiesel fuel.
New Mexico	Credit of 3¢/gal phased to 1¢/gal by 2012 for B2 or higher blends	Tax deduction for certain components of production		B5 by 2012	B5 by 2010 for state, local govt. and schools	
New York			50% credit on refueling stations. Grants for refueling stations		B2 now to be annually increased to B10 by 2012. 450 gals of B100 consumption offsets one required energy efficient vehicle purchase. B5 heating oil by 2012.	Franchise dealers cannot be prohibited from getting biodiesel from non-franchise supplier.
North Carolina		Until 2010, tax credit equal to fuel tax paid by producer who makes more than 100,000 gal/yr. Credit of 25% to 35% of construction costs	Credit of 15% of construction costs. Grants for refueling stations		EPAct credit sales pay incremental cost of B20. 20% reduction in petroleum fuels by 2010.	
North Dakota		10% equipment tax credit	10% equipment tax credit. 5¢/gal tax credit for B5 or above blends			Buy down of interest rates on production facilities, feedstock and refueling infrastructure
Ohio			Infrastructure and fuel purchase grants		DOT fleet to use 1 M gal/yr of biodiesel blends	
Oklahoma	Self production and use are exempt	20¢/gal tax credit until 2013				0% loans to governmental entities and school districts for refueling infrastructure
Oregon			35% credit on alternative fuels infrastructure	In Portland B5 now and B10 by 2010	In Portland B20 city vehicles	Loans for production facilities, feedstock production, and fueling stations.

State	Fuel Tax Credit or Exemption	Other Tax Exemptions, Deductions, or Credits or Incentive Payments		Fuel Mandate	State Vehicle Mandate	Other
		Production	Distribution & Retail Sales			
Pennsylvania						General alternative fuels grant program that includes biodiesel
Rhode Island	Organic biodiesel fuel produced in-state is exempt		Tax deduction on sales. 50% credit for fueling station construction. Both expire 1/1/08		450 gals of B100 consumption offsets one required energy efficient vehicle purchase. 5¢/gal purchase preference for B100 portion of any fuel	
South Carolina		Tax credit of 20¢/gal soy biodiesel. 30¢/gal all others. 5 years eligible. 25% credit on constructions costs.	25¢/gal payments for B100 sold starting 7/1/09, ending 7/1/12. 25% credit on construction costs	School buses required to use biodiesel when feasible	Only B5 or greater at fueling stations by 2008	2007-2012 25% tax credit for R&D on production and feedstocks including algae.
South Dakota		Tax credit for new facilities over $4.5 M in value			B2 minimum	
Tennessee		Fund established for production payments	$12,000 per county for biodiesel infrastructure	B20 limit on biodiesel sold to public	20% reduction on petroleum use by 2010	Ag Dept. to do R&D on biomass conversion to fuels
Texas	Biodiesel portion exempt	3.2¢/gal production fee charged				
Utah						
Vermont						
Virginia		10¢/gal payment (at least 2 M gal/yr production)			B20 to the maximum extent feasible	
Washington		Property tax exemption and reduced business taxes	Tax exemption on new retail sales and distribution infrastructure. $50,000 for refueling stations	B2 by 11/30/08 provided enough in-state feedstock. B5 once enough in-state feedstock to support 3% blend.	B20 by 6/1/09	Research grants & clean school bus funding.
West Virginia						
Wisconsin					10% reduction in diesel use by 2010, 25% by 2015	Incremental cost paid, as monies are available, for biodiesel use by school buses
Wyoming						

Appendix I - Biodiesel Feedstocks

Oil Seed Crop Yields*

Crops highlighted have been tested at UNH, UVM or University of Maine

Ascending order

Crop	kg oil/ha	litres oil/ha	lbs oil/acre	US gal/acre
corn (maize)	145	172	129	18
cashew nut	148	176	132	19
oats	183	217	163	23
lupine	195	232	175	25
kenaf	230	273	205	29
calendula	256	305	229	33
cotton	273	325	244	35
hemp	305	363	272	39
soybean	375	446	335	48
coffee	386	459	345	49
linseed (flax)	402	478	359	51
hazelnuts	405	482	362	51
euphorbia	440	524	393	56
pumpkin seed	449	534	401	57
coriander	450	536	402	57
mustard seed	481	572	430	61
camelina	490	583	438	62
sesame	585	696	522	74
safflower	655	779	585	83
rice	696	828	622	88
tung oil tree	790	940	705	100
sunflowers	800	952	714	102
cocoa (cacao)	863	1026	771	110
peanuts	890	1059	795	113
rapeseed	1000	1190	893	127
olives	1019	1212	910	129
castor beans	1188	1413	1061	151
pecan nuts	1505	1791	1344	191
jojoba	1528	1818	1365	194
jatropha	1590	1892	1420	202
macadamia nuts	1887	2246	1685	240
brazil nuts	2010	2392	1795	255
avocado	2217	2638	1980	282
coconut	2260	2689	2018	287
oil palm	5000	5950	4465	635

* The yield figures are most useful as comparative estimates, crop yields vary widely.